INTERNATIONAL PROJECTIONIST

JANUARY 1938

VOLUME 13 • NUMBER 1

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A Message to Projectionists

WE appreciate the confidence you have shown, over the last ten years, in the ability and integrity of our engineers. We believe that, over those years, we have learned thoroughly to understand your daily and emergency problems, and under the name Altec we will extend our cooperation in meeting those problems shoulder to shoulder.

We intend to do this without restriction as to contract or type of equipment. Our friendly relations of the past ten years continue with an even closer bond. You may call upon the Altec engineer as a friend—and that goes for all of us in Altec.

L. W. Conrow
PRESIDENT

ALTEC
SERVICE CORPORATION

"THAT YOUR THEATRE MAY NEVER BE DARK"

THERE IS A NEW NAME THAT MEANS "BOX OFFICE INSURANCE" TO EVERY EXHIBITOR

THIS page is an announcement—and a dedication.

It is addressed to the motion picture exhibitors of America.

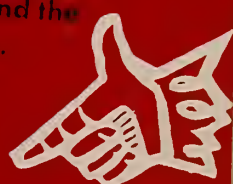
It announces a new organization in the field of service to the nation's exhibitors.

It dedicates itself to a broader and more complete conception of technical service than the exhibitor has known in the past. It aims to be a vital element in "box office insurance"—"that your theatre may never be dark"....

Altec Service Corporation dares to make so sweeping a self-dedication because Altec, although a new and wholly independent organization, soundly organized, soundly financed and soundly manned, is at the same time a mature, seasoned organisation, backed by ten years' experience in the field.

Altec embarks on its independent career with the integrated knowledge and capacity for team play of picked men from the engineering, sales and service staffs of Electrical Research Products, Inc., and still enjoys the co-operation of Bell Telephone Laboratories, as well as the full resources in the field, in men and material, established by Electrical Research Products, Inc.

Altec Service Corporation, alert, alive, aggressive, will do everything in its power to deserve, to secure and to maintain, the esteem and the good will of the exhibitors of America.



it is **ALTEC**

SERVICE CORPORATION

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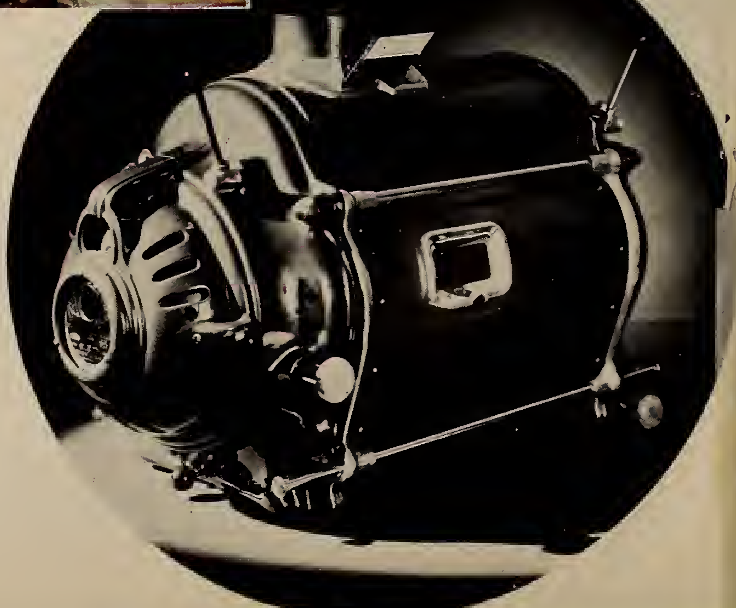
Walter Wanger's Vogues of 1938"



THE MAGNET THAT PULLS THEM IN

Todays critical audiences' demand for quality projection can best be met with Peerless Magnarc High Intensity Lamps.

In no other lamp is it possible to obtain so much value for first cost expenditure and such a great degree of purchase satisfaction after installation. The proof of this lies in the fact that Peerless Magnarc outsell all others two to one.

High intensity projection has been found an absolute necessity by one-third of all theatres in the United States — and these theatres have 75 per cent of the total seating capacity of the country.

This modernizing of projection has been brought about mainly by Peerless Magnarc's ability to produce 200 to 300 per cent more light on the screen for the same current cost of low intensity lamps. Think what this means in better picture quality, audience satisfaction, competitive advantage. Then write for the new folder, "Get A Seat On The Bandwagon."

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International PROJECTIONIST

With Which is Combined PROJECTION ENGINEERING

Edited by James J. Finn

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MONTHLY CHAT

FOR years we have been half-sold on the idea that we were directing our fact and fancy in the form of words, illustrations, ink and paper to one of the most unresponsive audiences extant. Only when an occasional error crept into print, and we heard from the folks back home, did we waver in the aforementioned belief. But we've been forced to revise our opinion on this topic, because there is evolving out of our current Prize Contest a type of constituent heretofore unknown to this corner.

More than 200 projectionists (at this writing) bothered to write two- and three-page answers to the Contest questions, including not a few drawings. And good stuff, too. To top it off, a manufacturer recently told us that his I. P. advertising netted him six times as many replies as any other medium. Really, we're beginning not to recognize our own people. Of interest is the fact that Contest replies from small towns outnumber by three to one those from alleged big towns. City fellers evidently are either too smart or too complacent or too near service facilities. The little-town fellow is pretty much on his own.

All of which compels a drastic revision in previous conceptions of the responsitivity of the projectionist craft.

REPORTS that a 9 mm. Suprex carbon has been available for quite some time now are hereby declared to be erroneous. The new Suprex size probably will be larger, about 10 mm.

YOUSE guys what don't like the new I. P. cover shown publicly for the first time with this issue will oblige by stating why. We intended to revamp the inside too, but we're still quarreling with the printer about the purchase of new type fonts.

A TOP-FLIGHT Mass. official likes to view motion pictures from the center balcony—but must sit on the main floor because of projection room noise (mostly projectionist jabbering). How many such dissatisfied customers are there?

THE projectionist at a theatre in an isolated Canadian town runs a radio store as a sideline, on the letterhead of which appears this statement. "A good radio will keep husbands home at night."

PRODUCTION notes: West Coast technicians are trying to revive the wide film idea. At least one major company laboratory is edge-waxing all prints, which practice has been repeatedly demonstrated to be harmful rather than helpful to the projection process. Improving the Standard Release Print is great stuff—if the original specifications, particularly with respect to change-over dots, were faithfully adhered to.

INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 1

JANUARY 1938

Outline of the Requisites For A Competent Projectionist

By *A. C. SCHROEDER*
MEMBER, PROJECTIONIST UNION 150, LOS ANGELES, CALIFORNIA

Many readers will applaud, many disagree with, this provocative contribution by a noted projection craftsman. Here is provided a fine springboard for those not afraid to take the plunge into the pool of opinionated comment—and incidentally contribute to a most interesting forum on projection practice.

WE OFTEN hear that it requires little knowledge and training, or both, to be a projectionist. Anyone can learn in short order to "thread a projector and push carbons into a lamp"—but does this make a projectionist? There is so much more to projection that probably none of us knows all about it.

Projection embraces electricity, mechanics, optics, sound, mathematics, lubrication, the ability to manipulate controls *at the right time* and showmanship. Some of us have a passing acquaintance with all these subjects, but the majority of us have a fair knowledge of only a few.

It might be argued that a man who can manipulate controls and who possesses showmanship can run as good a show as anyone else. I wonder. I know of theatres which are indifferent to capable projectionists; they want button-pushers. I have never seen shows in these houses during which the picture was not discolored. Is this just a coincidence, or otherwise? The equipment is not at fault, because they operate different lamps with unvarying results.

There have been other instances indicative of incapable projectionists—one being a twenty-minute stop which should have been corrected in two minutes. This particular trouble required just a bit more knowledge than the projectionist had. Another house had a twenty-five minute "intermission" due to sound outage, caused by a blown fuse: the boys simply waited until the serviceman arrived. Another instance was a faulty switch in the exciter lamp circuit, which could not be located, so the boys ran one machine until they received help.

Such troubles should not require servicemen. The exciter lamp trouble was as simple as the switch in the machine motor circuit, yet the boys were stumped because *it was in the sound system*. A little more knowledge than these men had would be a definite asset—to themselves, to the craft.

What should the projectionist know about electricity? In this, as in other subjects listed, each man must decide for himself. I believe that he should know all that he can learn. What *must* the projectionist know about electricity? Apparently nothing, today; but will it still be so ten years from now? Younger men are entering the craft who know more about electricity, and the other subjects, too. Many older men probably excell only in showmanship. One acquires this ability over a number of years. The newcomer cannot learn it

immediately. Much of the other stuff he learns in high school before he ever sees a projection room, knowledge which many men who have been operating for years have never acquired.

Projectionists' knowledge of electricity differs from that of wiremen. There is no need to know about pulling wires, or otherwise doing a workmanlike job of wiring. A great many electricians are not proficient at trouble-shooting. Projectionists *should* be proficient thereat, but most of them are not. It is seldom necessary to "ring out" a circuit, but could *you* do it in an emergency? Could you find the trouble if the circuit rings out OK, yet you get only a spark at the arc? It would be embarrassing to enlist aid on such a simple problem.

Ohm's Law a Definite 'Must'

Knowledge of the electron theory is not necessary but those who know about it have little difficulty solving such problems. A thorough understanding of Ohms Law is invaluable. If you do not have to stop and think before applying it, you have mastered the first big step. You cannot master electricity until you do thoroughly understand Ohms Law. It enables you to *immediately* interpret test lamp or meter procedure, or why a battery and buzzer will not test through a circuit where the same battery and a headset will, *etc.*

The mechanics section includes plenty, and some knowledge of the machinist's trade helps. A real machinist would ordinarily not have much to do in the projection room, but he would be very helpful on special occasions. The projectionist should know about the different kinds of fits between a shaft and its bearings. A slow-moving, heavily-loaded shaft of large dimensions requires a far different fit than does a small high-speed spindle. There is also the temperature to be considered. One should know that a bearing may be too large for the shaft, yet, due to misalignment of two bearings, may *seem* too snug. An example is the two bearings for the intermittent shaft, which may be out of line, causing the shaft to bind, or at least to be too tight. There are other causes for a shaft to bind, the key to which is a knowledge of the machinist's trade.

Many projectionists know that dowel pins hold adjoining parts in alignment, but they do not realize that a sharp blow with a hammer causes the dowels to give: the parts shift slightly and so cause trouble. It is sometimes necessary to file a surface perfectly flat; or, if unable to do this, to employ a trick that produces the flat surface without filing. Then we should know how to determine if the surface *is* flat.

Do you know that it is impossible to drill a true round hole? Some projectionists purchase lathes which help them in their work. They discover, however, that it isn't a case of just sticking metal in the machine and putting it to work, but that it requires practice and experience before good work results.

What do we know about optics? Not much. What *must* we know about optics? Again the answer is nothing. It is a funny condition when we can handle such a complicated business as projection and still get by knowing so little about it. We have a source of light, the arc; but how many know how the light gets to the screen to form the picture? When the light reaches the surface of the condenser the rays are refracted or reflected. When using a mirror the refraction is of no importance; but with condensers it causes the light to concentrate at the aperture.

When the light reaches the objective lens it is refracted in varying degrees. White light consists of colored light, and some colors are refracted more than others. If this condition were not corrected, two dots, one red and the other blue, occupying certain relative positions on the film, would not be projected to the corresponding positions on the screen. Use is made of the different refractive powers of the various kinds of glass, and when these are used in certain combinations they have the property of cancelling these faults, and the two dissimilar dots are projected to the proper points on the screen.

Care of Lenses, Mirrors

An uncorrected lens projects an imperfect image even when the film is not colored. If the film had a white dot and the rest of it were black, the picture on the screen would be a white dot surrounded by a colored fringe. The white center is where all the colors overlap (white consists of all colors); the colored fringe is where only some of the colors overlap.

We think of glass as an extremely hard substance, but actually it is relatively soft: many metals and even dust particles easily scratch it, indicating that careful cleaning is necessary. A lens scratch will throw light rays in wrong directions, causing loss of light and reduction in the sharpness of focus. If the lens surface is very dusty, dust it lightly with a very soft brush and then clean it with lens tissue. Sometimes silk or chamois skin is recommended, but some authorities assert that silk has very hard fibres which cause fine scratches. Chamois may have dust or grit embedded in it. Lens tissue is the safest.

Small air bubbles in a lens do no harm, causing only a small light loss and indicating that good optical glass was used. A lens with many bubbles is not desirable, but one or two small bubbles do no harm.

If projectionists understood the nature of sound, they would be able to grasp the servicing of the equipment more readily. By sound we mean just that—what we hear. There is no sound in the amplifiers or on the film. A study of sound shows us what occurs when a microphone is spoken into or when a loudspeaker reproduces that sound.

Theatre acoustics is nothing for the projectionist to worry about at present.

Acoustics still is an involved subject, but there is much that the layman can learn. In the auditorium sound is reflected, absorbed, or transmitted when it strikes a surface, depending upon the nature of the surface. Probably all three occur, but in varying degrees. As various kinds of glass react differently on different colors of light, so do different materials cause various results when high or low sound frequencies strike them. One material reflects 10 per cent of a certain low frequency, and only 3 per cent of a particular high frequency. Another material may reflect the same amount of that low frequency, but possibly only 1 per cent of the high frequency. In this manner the acoustic engineer can treat an auditorium to im-

Projection Today

THE motion picture projector is no longer a mere mechanical contrivance, cranked by hand or made to operate by the simple closing of a switch. The projectionist of today must have an excellent knowledge of mechanics, electricity and optics, and is in charge of a delicate and complicated mechanism made with scientific accuracy to handle a fragile and inflammable material.

The projectionist has a great responsibility, for a failure to measure up to the right standards means that all that the producer, director, actor and cinematographer have striven for loses much of its artistic and commercial value, the pleasure of the audience is lessened, the exhibitor is subjected to constant and unnecessary expense, and lives and property are endangered.

prove the reproduction of sound film.

The angles of the various surfaces in the house also influence the final result. Large flat or curved surfaces sometimes cause trouble, and must be broken up, or some material capable of absorbing most of the sound must be used. On the other hand, a rough surface might be used to disperse the sound in all directions and thus overcome the effects of the even smooth surface.

The projectionist should know mathematics (doesn't he have to figure his pay check?). The simplest problems occur in figuring the running time of the show, schedules, *etc.* Then we have the length of carbons required for various reels. Many of the boys have reduced these to a number of tables, one for the running time in minutes starting with 90 feet and continuing up to about 12,510 feet. Another for carbon lengths, allowing so many hundred feet for each inch of positive and a different figure for each inch of negative.

We used to calculate the size of lens needed under given conditions, but now we use tables, and it is only the newcomer who remembers the formula. How much math the projectionist needs is again dependent on the individual. Some cannot get enough, others are satisfied with very little.

Some knowledge of lubrication is a good thing. How much oil to use is a question, so we use enough to assure proper lubrication, thus most of us use too much. What oil to use is also a problem, occasioning much discussion. It is conceded that mineral oil should be used, but there is little agreement about the correct viscosity. The lighter oils are more highly refined than the heavier ones, thus are better. The heavier automobile oils (often used when projectionists desire a heavy oil) are originally light, then a filler is added to give it more body. This filler is an adulterant, not a lubricant. The heavier oils cause more drag, making the machines run harder.

Many projectionists think that a heavy oil is needed when the load on the shaft is high, but a light oil will support practically the same weight per square inch as the heavy oil. Beyond a certain pressure per square inch the oil film fails, and we have metal-to-metal contact, which quickly ruins the surfaces.

Advance Planning, Showmanship

There should be no acid, dirt, or other foreign matter in the oil. Not all oil is free of acid, and some of the widely advertised oils are said to be diluted with kerosene. Acid and dirt are harmful, kerosene probably does no harm, but neither does it help. I prefer a white dynamo oil, light and of good quality; if bought in fairly large quantities it is cheaper than the usual run of oils bought in small bottles or cans, and it is better.

A button-pusher may sound funny as a phrase, but it is not funny when done incorrectly. The expression, of course, refers to dimmer handles, foot switches, *etc.* In a new situation I find it helpful to think out the sequence of operations beforehand; there is no time to do this at the moment of making the change. I have seen experiencd men "miss" through neglect of this simple process. This may not be necessary for everyone, but it will help the majority.

Showmanship is the quality of knowing what or how things should or should not happen during the show. As an illustration, let us consider trailers. A man should instinctively know that it is poor practice to open or close the show with the announcements for next week. There are times when different parts of the show should follow each other rapidly and without a break. At other times, a picture with a tragic ending is more impressive and the patrons receive less mental jar if a few seconds elapse before starting the next subject, especially if it be a comedy.

Even if an intermission follow the sad ending, it might be advisable to allow the house to remain in darkness a few seconds and then bring up the lights slowly. On the other hand, if a comedy finish with a lot of laughter, it is just as well to immediately light up the house with the audience still laughing.

Projectionists do not agree on all phases of showmanship, but neither do the managers. Some people acquire this trait rapidly; others seem never to learn it. Some people instinctively do the right thing at the right time, while others do everything wrong.

Newcomers Are Better Fitted

The foregoing is the writer's idea of what a projectionist should know. It covers a lot of ground, and projectionists have all sorts of ideas on the subject. One thing is certain, the younger men are better educated in more of the subjects than the oldtimers. As time goes on projectionists as a whole should be more capable. The newcomers make every effort to learn all they can about the business, but after a few years most of them get into the same mental attitude that the older men have, and learning either ceases or diminishes greatly.

S. M. P. E. Discussion of Stereoscopic Pictures

UTILIZATION of advance proofs by I. P. in order to bring to its readers promptly important S. M. P. E. papers usually means that publication of the discussion incident to a given presentation must be postponed. While such instalment publication is not adaptable to all technical papers, it is entirely feasible with presentations such as that anent three-dimensional motion pictures, employing Polaroid analyzers, previously published herein.[1]

Appended hereto are excerpts from the discussion which followed presentation of this particular paper at the most recent S. M. P. E. Convention:

Mr. Bradley: What is going to be done about eye-strain in using these glasses?

Mr. Wheelwright: The pictures we showed were taken by an amateur and were not perfectly projected. There is no reason why there should be any eye-strain, but there are a number of reasons why in photographing or in projecting, differences in image size can be mistakenly or intentionally produced. Also, individual glasses may show imperfections.

Mr. Bradley: If the glasses were made according to prescription by a skilled optometrist, could that be overcome?

Mr. Wheelwright: Yes, entirely. Polaroid is being worn in front of the eyes now for hours and hours on end, with no noticeable eye-strain when properly mounted. There is nothing inherent in polarization that would lead to eye-strain that we can discover.

[1] "Stereoscopic Motion Pictures: Past, Present and Future," by G. W. Wheelwright, I. P. for Nov., 1937, p. 15.

Mr. Richardson: What is the effect, if any, of distance from the viewing screen?

Mr. Wheelwright: We have to be careful about foreground objects and background objects. We must also consider the permissible viewing area. With a 16-mm. projector and 16-mm. film area, we are straining matters in showing the pictures to 200 persons. With 35-mm. film the permissible viewing area is larger. Actually, there is only one very small area where everything is exactly accurate, but there is a large area in which things are what might be termed permissibly accurate. Frankly, that area has yet to be determined.

Mr. Edwards: Is it not possible that apparent eye-strain is caused by having one glass adjusted horizontally and the other vertically?

Mr. Wheelwright: There is no reason why polarization in different planes should cause eye-strain. If one were viewing reflected glare, where polarization is a function of the angle at which the glass is set, there would be a very definite reason for eye-strain. Here the two pictures are of the same brilliancy, and the glasses are supposed to be crossed properly. Professor Kennedy has had glasses made according to his prescription, and has worked for periods of eight and ten hours doing nothing but viewing pictures without eye-strain.

Mr. Finn: The proportion of those who experienced strain seems to be about the same in the fore part of the room as in the rear. I seemed to detect certain lapses of registration, and it occurs to me that such

(Continued on page 31)

Contest Notice: An important change in the rules applying to the Awards Contest based on the special series of articles by Aaron Nadell is dictated by experience with the first group of answers. The time limit of 20 days originally established for receipt of Contest answers in the offices of I. P. has been found to restrict unduly those readers far removed from publication headquarters; also, the large number of answers which reached I. P. either on or after the deadline date testified to the urgent need for an extension of the time limit.

In the future, therefore, the deadline for Contest answers will be on the first day of each month, representing an extension of ten days time. This change in Contest rules, while necessitating the omission of prize-winning names from this issue, undoubtedly will result in a more widespread interest in the Contest. Some 219 contestants have submitted answers to last month's questions as these lines are written (some from England, South America, and the Canal Zone), and the winners (with photos, we hope) and their prizes will be announced next month.

Meanwhile there is appended hereto the second Contest article, for the best answers to which another fine assortment of prizes will be awarded, including meters, test sets, tool kits, and other valuable projection accessories.—*Editor.*

Analyses of Modern Theatre Sound Reproducing Units

By *AARON NADELL*

II. Amplifiers

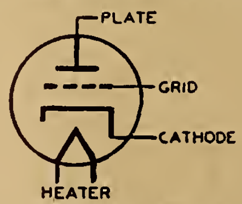
ALL amplifiers are trigger-operated devices, working on a supply of smooth d.c. The fact that seemingly only a.c. enters the amplifier, often the case, makes no difference. Such amplifiers include internal provisions for converting a part of the a.c. to the smooth d.c. The amplifier, we may say, "corrugates" the smooth d.c. supply, making of it a pulsating d.c. in which the pulsations occur at speech frequencies. The pulsating d.c. thus obtained is usually further converted to a.c. of the same speech frequencies.

In this work the amplifier uses a model or guide provided by the a.c. or pulsating d.c. speech input, which in turn is derived from the photo-electric cell or from the output of another amplifier. It is this speech input that operates the "trigger." A good amplifier works with such precision that its output or duplicate speech power is an exact reproduction of the "trigger" input, only stronger. In some cases the output is not actually power, but only voltage, accompanied by no appreciable flow of current—in which case the device is called a "voltage amplifier."

The use of a voltage amplifier lies in this: frequently the controlling input, which operates the "trigger," does not have to carry any power to speak of. The trigger works, as will be seen, on voltage alone applied to what is, electrically speaking, a condenser of very low capacitance. A large change in the voltage, or charge, of that condenser can be achieved (because of its low capacitance) by an extremely small flow of current — so little that the current is commonly regarded as almost zero, and is seldom considered.

For practical purposes it is entirely in order to think of the voltage as acting alone, and the power as substantially non-existent. Thus, when the only function of an amplifier is to provide speech input for another and larger amplifier, a voltage output alone may be sufficient.

However, when the amplifier is used to operate any device that does work, such as a loudspeaker, power is obviously needed, and a mere voltage output will not serve. Also, when an amplifier is to be used to supply input for another amplifier of the Class B or Class AB kind, voltage alone again will fail to serve. In Class B and Class AB amplifiers the trigger needs more than voltage to make it function effectively.



Triode Type Tube

Tube is the Real Amplifier

Essentially (with an exception to be noted) the only amplification that ever occurs—the only trigger action, at least —takes place in the tube. No matter how bulky the apparatus may be, the comparatively small tubes do all the real work; the rest of the material is there only to help the tubes—to lead input to them and take output away, to bring up the smooth d.c. which the tube moulds to pattern, *etc.*

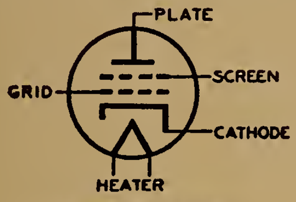
Most theatre amplifiers today contain "power packs" which provide the necessary d.c. out of a line a.c. input. These circuits, however, are properly classified under power supplies, and play no inherent part in the amplifier action. They are excluded from the present discussion.

An amplifier consists, then, of sockets, or means for mounting tubes, and for connecting the necessary circuits to them. Then of wiring that applies the necessary d.c.—plate d.c.—across each tube. Since tubes need a filament-heating current, another circuit applies that current to the sockets. Still other circuits bring up one or more grid bias voltages. All these auxiliary supplies must be of correct value as to both voltage and current, but there are no important questions of impedance match.

The speech input and output to the tubes must, however, maintain proper impedance relations with the tube itself. The correct relationship is not always an equal match. Best results may, in this case, be obtained when the tube output works into twice its own impedance; or other output impedance relations may obtain, depending upon the nature of the tube and the circuit. Input impedance is usually matched to some extent, but since the input impedance of a Class A amplifying tube is practically infinite, the usual procedure is to draw that in-

put from a source of several hundred thousand ohms.

Inter-tube coupling refers to the means used for taking the speech output of one tube and applying it to the "trigger," or input, of another tube for further amplification. Since the output of a tube is a few thousand ohms, and the input should be hundreds of thousands or a million obms, transformers are often used for coupling baving relativcly low impedance primaries and bigh impedance secondaries. Such transformers constitute the only exception to the foregoing statement that tubes do all the amplifying.



Tetrode Type Tube

A Class A tube needs only *voltage* input to work its grid or trigger (current is of no importance) hence the coupling transformer may be given a voltage step-up ratio, the effect of which is greater amplification. The benefit is not very striking, because transformer distortion results if the step-up ratio exceeds a very small increase, and many theatres use no coupling transformers. The plate of one tube is properly loaded with a resistor of a few thousand ohms value; a pair of condensers, or a condenser and common return, link that resistor to one of several hundred thousand ohms, and the latter in turn constitutes the source of input for the next tube.

The high value of the input resistor is of definite benefit in promoting amplification in any tube that works on voltage only. Thus, the output of a p.e. cell may be only microampere; but if that current completes its circuit tbrough a resistor of one megohm, the voltage drop across the resistor will be one volt—enough to work the grid of a small tube very satisfactorily, while the power is only one microwatt.

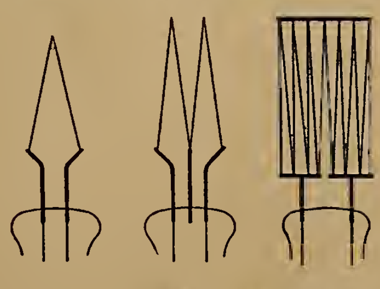
Tube Construction Data

Tubes are sensitive devices in which the current value of a d.c. circuit is controlled by voltage input that requires, in Class A operation, very nearly zero power. This sensitivity is achieved by compelling the d.c. in question to leave its metal conductors and travel for a short distance through a vacuum, wherein it passes through the meshes of a metal screen, to which the controlling voltage is applied. Under these circumstances the d.c. value is extremely sensitive to the extent of the charge, or voltage, of the metal screen, and small cbanges in that voltage will cause comparatively large changes in the strength of the vacuum current.

The current is emitted, or projected, into the vacuum by the simple process of heating the end of one of the conductors. Every conductor, under all circumstances, constantly loses, sheds, emits small quantities of current (small numbers of electrons) into its surroundings. This is true even when the conductor is not supplied with electricity—the electrons come from its own material. The property of giving off electrons easily is what makes a conductor conduct. When a group of electrons, constituting a current, enter a conductor they shove ahead of them the easily detachable electrons of the conductor's material, themselves taking the vacant places until shoved ahead in turn by additional current entering after them.

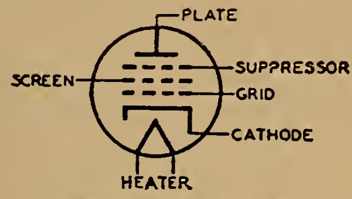
Now, all materials that are not at absolute zero of temperature (273 degrees below Centigrade zero) are in continuous internal agitation, the energy for which is supplied by the surrounding heat. If the electrons of the substance are readily detachable, the agitation shakes some of them loose from their moorings. Those that happen to be detached close to the surface of the material may continue right through that surface and out into the surrounding space. If the substance is heated, the internal agitation increases in intensity, and the emission may be increased to the point of releasing enough electrons to constitute a sizeable current. Some conductors emit much more easily than others, for a given temperature; the emitting conductor, or cathode, in a vacuum tube is made of materials that are exceptionally efficient in this way.

The necessary heat is applied by means of a heater (or filament) current, supplied to the tube for that specific purpose. The emitting material may be coated upon, but insulated from, the heating wire, or filament. On the other hand, the filament itself may be made of a metal which is a good emitter, and does double duty as a cathode, in which case it will carry two separate currents, the vacuum d.c. and the heating current, which latter may be eitber d.c. or a.c.


DIRECTLY-HEATED CATHODES
(FILAMENT TYPE)

Where the heating wire and the emitter are insulated from each other, the tube is called a heater tube. Where the filament performs a double duty and carries two separate currents, the tube is said to be a filament type. Both types may be found in the same amplifier.

Electron emission into a vacuum is not enough. Electrons are all negative; an accumulation of electrons constitutes a negative charge; absence of the normal quantity of electrons amounts to a positive charge. The emitter, baving lost electrons, is positively charged, and will re-attract them unless a stronger positive charge is provided in the immediate vicinity.

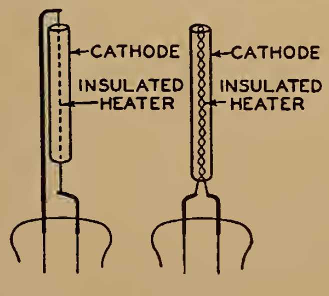


Pentode Type Tube

The other terminal of the vacuum current, the anode, is positively charged from the d.c. source of the vacuum current and attracts the emitted electrons to itself. They return to the emitter through the external circuit; tbus the process can keep up indefinitely as long as an external source of d.c. potential is applied to the tube to furnish the necessary energy to keep the electrons moving around, back to the emitter, and around again.

With such external potential applied, the value of the vacuum current will depend in part upon the anode voltage, since there are two opposite forces at work on each electron. The cathode which it has just left, although usually considered as negative (which it is by comparison with the anode) is nevertbeless positive compared with the electron itself, and attracts it. The anode is positive compared with botb electron and cathode.

An electron halfway between the two will be drawn to the anode, whicb is the stronger charge. But at a point close to the emitter the weaker but nearer charge may predominate, and an electron at that point may return wbence it came, reducing the vacuum or space



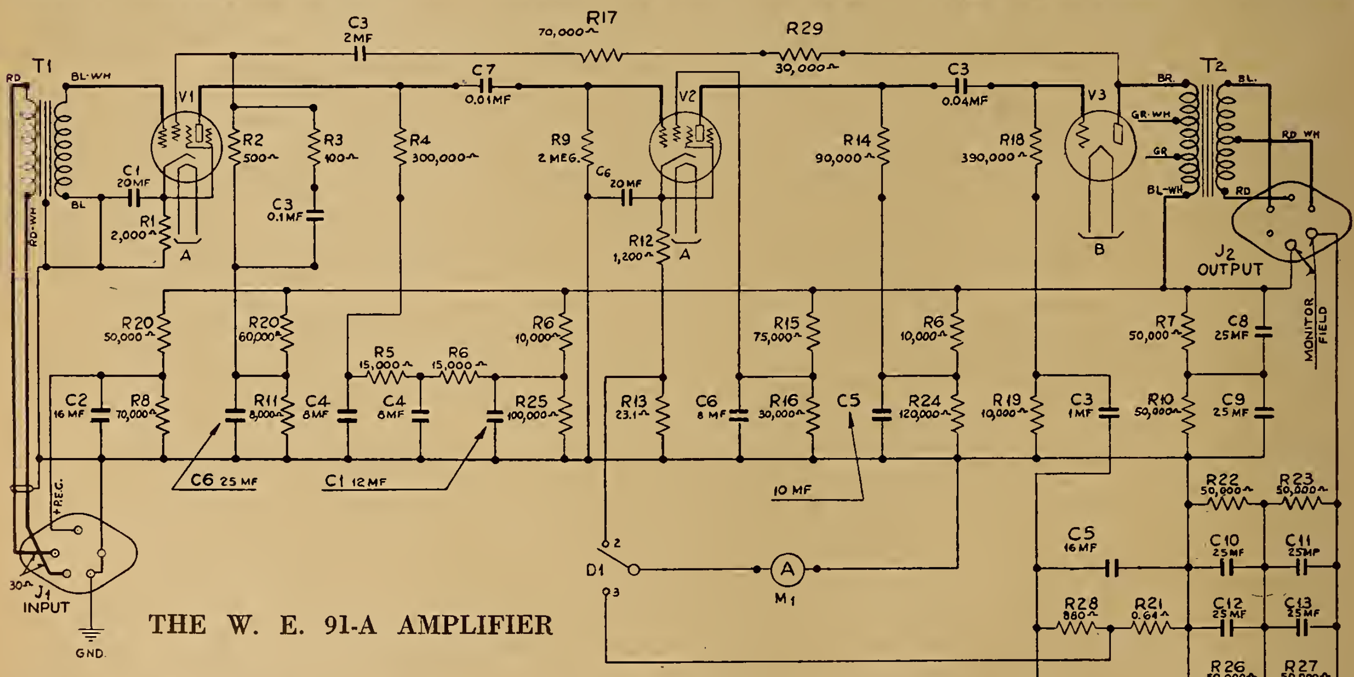
INDIRECTLY-HEATED CATHODES
(HEATER TYPE)

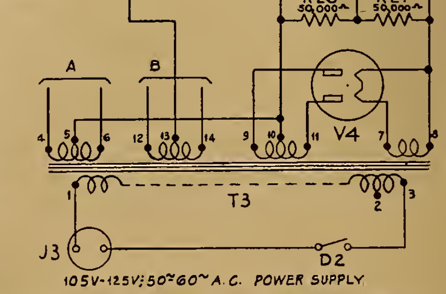
current by just so much. The greater the positive charge of the anode, the better its chance of attracting those electrons which are emitted with low velocity and therefore do not travel very far from the cathode.

Since the vacuum is in series with the external anode or plate circuit, all electrons that cross the vacuum must complete their return to the emitter through the plate wiring, and a meter in series with that wiring will accurately read the vacuum current. An increase in plate voltage shows a proportionate increase in vacuum current, up to the limits of the emitting power of the cathode—the vacuum in this respect obeying Ohm's Law like any other conductor.

However, the plate current can be increased without increasing the plate voltage merely by facilitating emission—that is, by raising the emitter to a higher temperature through an increase of the heating current. The effect is the same as reducing the resistance at the emission end of the circuit. Ohm's Law still holds good.

The resistance of the vacuum itself can be reduced by the introduction of very small quantities of gas. Bombardment of the gas atoms by moving electrons detaches other electrons from the gas, leaving the atoms positively charged. The positive atoms, now called ions, move to the negative terminal, or cathode, where their attraction helps to increase emission. They capture emitted electrons, only to lose them again by further bombardment, and again become positive, and again stimulate emission. The result is an increase in plate current with no increase in the applied plate voltage, or, effectively, a decline in the vacuum resistance resulting from the gas content. Ohm's Law *still* holds good.





THE W. E. 91-A AMPLIFIER

The grid of a simple amplifying tube is placed between the cathode and the anode. Cathode and anode are the two poles of the vacuum, or output, circuit. Cathode and grid are the two poles of the input, or control, circuit. In Class A operation a permanent d.c. charge is connected across grid and cathode in such polarity that the grid is the more negative of the two, thus negative electrons do not touch it and there is no flow of grid current. Because there is no such flow the grid bias may be applied through the input resistor of hundreds of thousands or millions of ohms. The presence of the resistor has no effect at all on the d.c. grid bias because there is no grid current. Similarly, grid bias can be obtained from very small dry cells (C batteries) which never wear out except through internal deterioration.

While electrons do not touch the grid, they are strongly influenced by it. An electron moving outward from the emitter is attracted by the positive anode and simultaneously repelled by the negative grid. If the grid repulsion is too strong, they return to the positive (comparatively) cathode. If the grid repulsion weakens, some of them slip through the meshes and go on to the anode. If the grid bias is set at a medium value, a small change in grid voltage may send multitudes of electrons back whence they came, or (if the change is of reverse polarity) admit multitudes to the anode that otherwise would never get there.

The input current to be amplified is merely applied between grid and cathode as a pulsating or alternating charge that modifies the grid bias. Charge, or voltage, is all that is needed. The comparatively strong plate current is moulded into an exact duplicate of the grid pulsations.

Noteworthy, however, is that there is some small flow of actual charge-discharge current along the grid wires. The electron accumulation at the grid, the charge, can be changed only by moving electrons on or off, and that motion of electrons constitutes a current. It is, however, an extremely feeble current. Grid and cathode, between them, constitute a condenser, and the number of electrons needed to change the condenser to a given voltage depends upon its capacitance. The capacitance being very small, comparatively few electrons are needed. Similarly, in the case of the permanent d.c. bias there is a temporary flow of electrons to the grid when the switch is first turned on. These must pass through the high resistance of the grid resistor, a process requiring a short time. The charge once established, however, does not change, and the resistor has no further influence on it.

Many tubes have more than one grid. A very new type is the co-planar tube in which two separate grids are originally so wound around the same form that they occupy the same location, or plane, within the tube, although insulated from each other. Each has an equal effect on the electron flow. Each is supplied with its own output, or trigger voltage, the sources of which are entirely different. Such tubes are

used in reverse feedback circuits that minimize distortion.†

More common is the screen grid, positioned between the control grid and the anode. Its function is to overcome certain limitations upon amplification inherent in the simpler three-element tube, or triode. In the latter, a reduction in grid voltage, originating with speech signal, results, as explained, in an increase in plate current. But, the source of plate voltage not being of infinite capacity, increased flow of plate current tends to reduce the plate's positive charge.

Inherent Tube Fluctuations

Now, plate and grid constitute a condenser. It has been said that an electric charge can no more exist without an equal but opposite charge existing somewhere else than a board can have only one side. If the plate voltage drops a little, the grid voltage must rise a little. But the grid voltage increase reduces the plate current again, causing the plate voltage to rise, which by the same condenser action again reduces the grid charge. In other words, there are small fluctuations inherent in the tube action, independent of the pattern of the input. Carried far enough, these fluctuations will make the tube develop an a.c. on its own account, that is, act as an oscillator. When things go that far, the only sound heard is a continuous squeal, howl or whistle, depending on the frequency of the a.c. generated.

Many theatres have a slight, high-pitched hum in the background of their sound, normally unnoticed, which is due to a slight degree of oscillation on the part of the amplifying tubes. In others, the oscillation is above audible frequency, but is heard through its interaction with the audible sound as distortion. Good amplifiers in good adjustment do not oscillate. The greater the amplification, however, the greater the tendency of the tube to oscillate.

High amplification without oscillation is promoted by reducing the condenser coupling between plate and control grid. A screen grid is placed between them for this purpose. It is positively charged, at somewhat lower voltage than the plate charge, and attracts some electrons. Most electrons, however, on reaching the vicinity of the screen grid are drawn further on by the still more powerful plate attraction, and pass through the screen meshes.

Suppressor Grid Effect

This construction makes possible higher amplification without oscillation, but in itself does not secure high amplification. Oscillation having been eliminated, secondary emission remains to be overcome. Many projectionists have seen tubes with plates so hot that they glowed a cherry red. The cause is bombardment by the vacuum electrons. But hot conductors, even when not made of emitting material, emit considerable quantities of electrons. When the plate is heated to the point of substantial emission, the electrons leaving it have no place to go—the plate being the most positive unit in the tube, they go back where they came from. Temporarily, however, each electron constitutes a little negative charge in front of the plate, which tends to repel the vacuum current coming from the cathode. Hence, the value of the vacuum current, and therefore the possible extent of amplification, are reduced.

This effect is overcome by introduction of a suppressor grid between the screen

(*Continued on page* 29)

†NOTE: Reverse feedback was explained in I. P. for Nov., 1937, "The W. E. 91-A Amplifier," p. 19. A co-planar tube may be used in place of V-1 in the 91-A amplifier, schematic of which accompanies this month's article.

Here are the Contest Questions—

5. The plate current meter of a given tube reads high. The plate voltage and all other voltages of the tube are approximately normal. What is wrong? What should be done to correct the condition?

6. Dirt in a socket results in open contact at the grid of a Class A tube. What result can be expected? Will sound be lost?

7. A short-circuit in or about a screen-grid resistor effectively connects the screen-grid with the plate. What will happen?

8. An internal tube defect short-circuits the filament to the control grid. What will happen in Class A amplification? In Class B? In Class AB?

Boston Local 182 Model Admittance Procedure Is Fair, Thorough and Efficient; Long Used

HIGHLIGHTING Boston Local 182 system of handling membership applications is group examination in writing of oral questions, as shown in accompanying photograph. First requisite for applicant is that he live within 182 jurisdiction and have had a projectionist license for two years preceding.

Next step is the appointment by the chair on the open floor of a meeting of an investigating committee composed of five men for *each* applicant. Any member has the right to challenge any appointment to investigating committee, thus insuring a fair shake for every applicant. Investigating committee then reports back to the body, which can accept or reject recommendations. If investigating report is accepted, arrangements are made for thorough examination of applicant.

Accompanying photograph shows a group examination, all applicants pictured therein having been members of Local 182 apprentice class, excepting five who were included through either transfers or organizing activities. Presiding over the examination are the five chairman of committees (shown standing) who shoot oral questions at applicants, who write their answers. No questions are written down in advance by interrogators, thus insuring the utmost secrecy. Paper of each applicant is subsequently checked and marked by the examiners, a report of which goes back to the body for final action on admission.

This is the finest procedure on Local Union admission to come to the attention of I. P., and it detracts nothing from the credit due Local 182 if other local units follow a similar, or possibly even better, procedure.—J. J. F.

This is how Boston L. U. 182 conducts a group examination

Film Aperture Rest Decision Rests Ill With Rest of Experts

POSTING of the decision in favor of Herbert (Simplex) Griffin in the battle of split seconds anent film frame aperture rest (I. P. for Dec., p. 22), far from settling matters, induced a flock of responses of an extremely critical nature directed not only at the referee (I. P. merely donated the arena for the battle) but also at a startled Mr. Griffin who was already sampling the fruits of victory. Some of the boys even hinted at a long count in Mr. Griffin's favor.

In brief, many of the boys good-naturedly cuffed Mr. Jack Leatherman, of Florida, suh, who alone was adjudged by Mr. Griffin to have submitted the correct answer. (p.s.: Mr. Leatherman having already beaten us for a one-year subscription renewal for his answer, we're on his side.—*Ed.*) These two-timers, that is, those who returned to the fray after the final gong sounded, are backing Walter Fink, who insisted that a film frame rests at the aperture for only 1/30 second, as compared with the 1/48 second entry of Messrs. Griffin and Leatherman.

It would be great sport if these "operators" who "merely throw a switch" (see any exhibitor report on projectionists) could shoot a smart uppercut and straighten up Mr. Griffin, who has lived with intermittent movements for 25 years; but since he got us into this thing, he must get us out.

Anyhow, we present herein several representative howls from the adherents of Mr. Fink, all of which not only subscribe to his proposition but go to rather extreme lengths to prove the point. While the burden of all these letters is the same, each adopted different tactics to get his message across. Mr. Gallery, of Auburn, N. Y., not only threw a verbal brickbat in the direction of Mr. Griffin but sent it winging on its way with a heavy wrapping of drawings laden with India ink and sharply-pointed indicia. The texts of these letters clearly indicate the point at issue, but it would be a pity to exclude the Gallery art work (Figs. 1 and 2), and the chances are that many readers will really appreciate this graphic presentation of intermittent movement action.

Mr. Mowery, brother Local member of Mr. Fink, takes a different but highly effective tack by means of having a Simplex intermittent engineer bear witness against Vice-President Griffin. (We're beginning to really enjoy this.) If this particular engineer doesn't leave suddenly on a vacation, it might be well if he and Mr. Griffin got together some afternoon in a corner of the Simplex plant and compared a few notes.

Mr. Garwin of Cleveland Local 160, while disdaining to draw any pictures, indulges himself in a select collection of sentences, which, while constituting no Vesuvius, contain enough heat to light a few cigarettes. 'Twas always thus with these Cleveland fellers. Nice playmates this fellow Fink has.

Aroused by this unexpected counterblast, Mr. Griffin re-enters the arena and lashes out with both hands, words and a drawing (Fig. 3), the latter in particular being his idea of the retort devastating. His reply is directed specifically at Mr. Garwin, but since all three dissenters stand on the same proposition, the Griffin opus is inclusively applicable. Here are the self-explanatory comments, with Mr. Griffin being accorded the last slot:

To the Editor of I. P.

Regarding the question of the time the film is at rest at the aperture, and that consumed during the motion of the film in a Simplex mechanism, I must differ with you, and Mr. Leatherman, and even with Mr. Griffin, in your solution. I may be sticking my neck out to get into a discussion on Simplex mechanisms with Mr. Griffin, but it is my opinion that he has put his foot into it, if you get what I mean.

My analysis of the problem is as follows:

At 90 ft. per minute, we are projecting 24 frames per second. The shutter makes one complete revolution for each frame, and requires 1/24 second to do so. Further, the shutter area is divided into four 90° segments, two of which are openings, one a cut-off blade and one a balance blade. The total screen exposure occurs during the time the shutter openings uncover the aperture and is 2/4 of 1/24 second, or 1/48 second.

The cut-off blade passes in front of the aperture during ¼ of a revolution of the shutter, and takes ¼ of 1/24 second, or 1/96 second to do so.

But, the film is *not* in motion during all of that 1/96 second. If it were, travel-ghost would be in evidence. That 1/96 second comprises first, the time consumed by the cut-off blade's entering edge to move down across the aperture and completely cover it—during which time the film is at rest; second, the time consumed by the *motion* of the film, and third, the time consumed for the cut-off blade's trailing edge to move off the aperture and uncover it, during which time the film is again at rest, remaining so until the aperture is again *completely* covered by the cut-off blade at its next revolution.

The motion required for the entering edge to just move across the aperture amounts to 9° of revolution; the same is required for the trailing edge to move off the aperture after film-motion has ceased. The cut-off blade is a 90° segment; of that 90°, 18° is used in covering and uncovering the aperture, leaving 72° for the actual film-motion.

In other words, film-motion consumes 72/90 of the entire time during which the cut-off blade is in front of the aperture, or:

$$\frac{72}{90} \text{ of } \frac{1}{96}, \text{ or } \frac{1}{120} \text{ second}$$

The film is at rest during:

$$\frac{1}{24} - \frac{1}{120} = \frac{5}{120} - \frac{1}{120} = \frac{4}{120} = \frac{1}{30}$$

second.

I believe that Brother Fink of Local 218 is correct in his solution, and I should like to see credit given where it is due.

ROBERT GARWIN
Park Theatre, Cleveland, Ohio

To the Editor of I. P.

I cannot agree with the "Decision Rendered . . ." anent film frame aper-

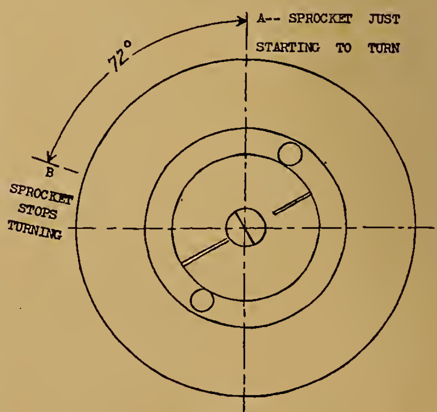


FIGURE 1

Representing flywheel end of Simplex intermittent. Place a piece of cardboard in back thereof and on this trace the periphery of the wheel. Rotate flywheel very slowly until sprocket starts to move. Mark flywheel and the circle on the board as Start (A). Rotate flywheel very slowly until sprocket stops, then mark card opposite flywheel mark. Lay out angle and measure, and you get 72°. Flywheel turns once every 1/24 second, and sprocket turns in 72/360, or 1/5, of that time, or 1/120 second. (J. Gallery.)

ture rest, as recorded in I. P. for December. I agree with Brother Fink of Local 218. I do not know how he arrived at his solution (he didn't make that very clear) but I shall try to prove that his answer is correct, *i.e.*, that the pull-down period is 1/120 second, and *not* 1/96 second, and that the "period of rest" is 1/30 second, and *not* 1/32 second.

It is true, as stated, that the Simplex is a 90° movement, but here is the joker: some time is lost while the cam pin is *entering and leaving* the star slot. Actually the movement of the sprocket occurs in 72° because of this lost time.

I enclose two drawings, one of the shutter with relation to the movement of the intermittent sprocket (Fig. 1), and one of the intermittent fly-wheel with relation to the movement of the intermittent sprocket. Both show clearly (I hope) that the sprocket movement occurs in 72°, or 1/20 second, and *not* 90°.

Therefore, the pull-down period is 1/120 second; the period of rest is 1/30 second, and the period of exposure is 1/45 second.

JAMES J. GALLERY
Local 119, Auburn, N. Y.

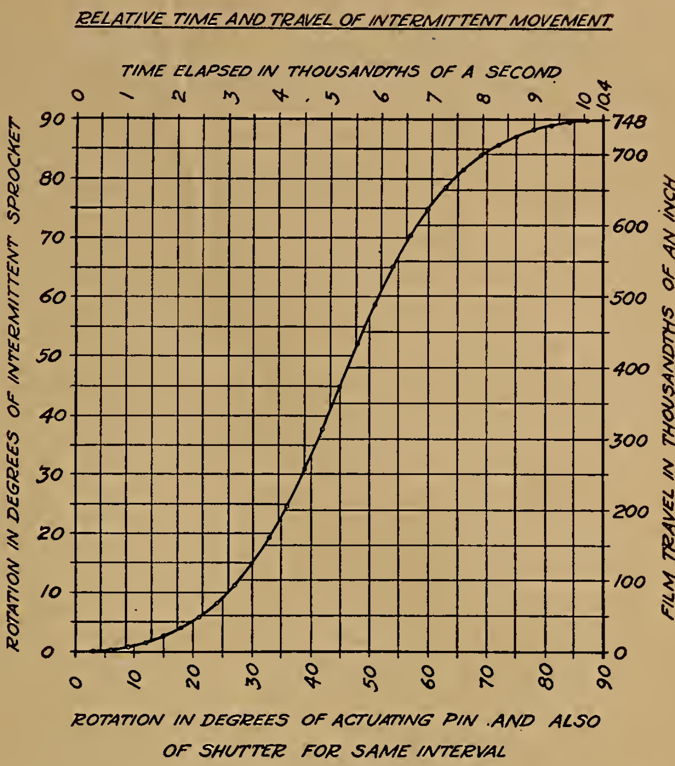


FIGURE 3

This is the result obtained by Mr. Griffin and a corps of Simplex engineers. These data cover four factors which enter into the question of film frame aperture rest

To the Editor of I. P.

I vote for Brother Fink's answer . . . The intermittent, comprising of cam and pin and star-wheel assembly, is a 70°, or 4-to-1, movement, and not a 90,° or 3-to-1, movement, as stated by Mr. Griffin. Cam and pin move 72° to turn the star-wheel 90°. How would Mr. Griffin eliminate travel-ghost with a 90° shutter and intermittent? If the cut-off blade were covering the aperture before the film started to move, the aperture would be entirely exposed to light before it stopped moving . . .

On a recent visit to New York, Brothers Adams, Weist and myself (also of Local 218) visited the International Projector plant. The chief engineer of the intermittent department informed us that the movement was 4-to-1, not 3-to-1, and verified my preceding statements. He also stated that the Powers movement was a little faster than the Simplex, being approximately 4½-to-1.

International Projector Corp. has had experimental movements with a ratio as high as 8-to-1 which give 35 per cent more light on the screen than does the present movement; but the film sprocket holes lasted for only three runs through the projector.

RAYMOND MOWERY
Mahanoy City, Penna.

To the Editor of I. P.

I read with a great deal of interest the letter from Robert Garwin of Cleveland, Ohio, and I was very glad indeed to receive this letter since it shows that the boys get to thinking about somewhat intricate problems and do not hesitate to publish their ideas.

Unfortunately, however, Brother Garwin is not quite right in his calculations, and I have had made up by our engineering department, after careful analysis, a chart showing the relative time and travel of the intermittent movement in time lapses in thousandths of a second, the rotation in degrees of the intermittent sprocket, the film travel in thousandths of an inch and the rotation in degrees of the actuating pin and also of the shutter for the same interval. This chart accompanies this statement.

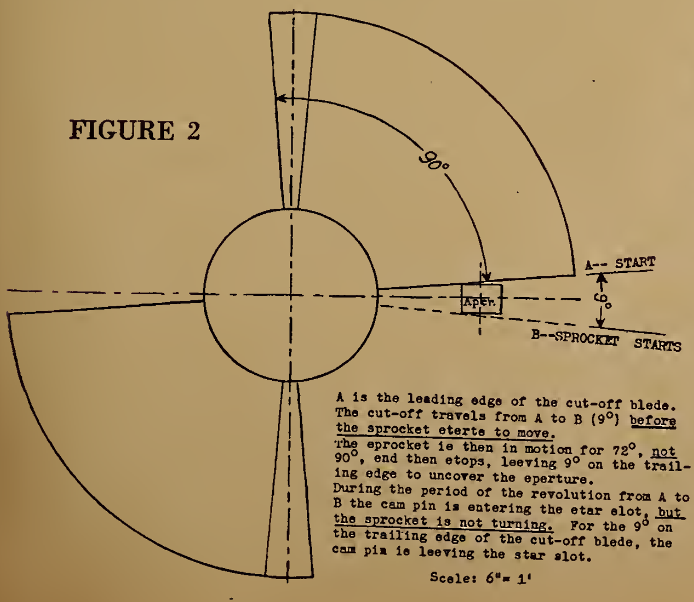
My original contention still holds true, since as nearly as it is possible to determine, the film is moving, for all practical purposes, during 1/96 second. It must be remembered, however, that all statements are made only in connection with a properly assembled and adjusted new intermittent movement.

In such a movement, the film during the first three dgrees of the pin travel moves .0007"; in six degrees .0028"; and in nine degrees .0069", and comes to rest in approximately the same figures. The film is moving, when the pin has entered the slot only three degrees, at a speed of 20 feet per minute, and it increases in speed up to 45 degrees approximately 870 feet, or 1/6th of a mile, a minute. It decelerates at the same speed.

In other words, the film speed at 45 degrees of the movement is about 43½ times faster than it is when the pin has entered three degrees. Under these circumstances, I am sure we can still assume that, for all practical purposes, the film is in motion for just about 1/96th of a second, and for just about 90 degrees of the movement.

HERBERT GRIFFIN

FIGURE 2



This drawing and attendant indicia is the method utilized by Mr. Gallery to sustain his point. Compare with Fig. 3 submitted by Mr. Griffin

Some Television Problems—
A Description for Laymen

By *ARTHUR VAN DYCK*
MANAGER, RCA LICENSE DEPARTMENT

This is the second and concluding instalment of this article, one of a series covering recent technical developments in television and charting the future of the art. Written by acknowledged authorities on the subject, this series should prove of great value to those interested in the progress of this baby art—as are most projectionists. These articles were compiled and are copyright by RCA Institutes, Inc. (except where another source is indicated) and appear herein through the courtesy of that organization.

II.

SO FAR, we have not considered the receiver specifically. That, to most people, is the most interesting part of the system. It seems to be the focal point of the thrill and mystery in "pictures from the air." So, let us now consider the receiver, but let us do so with clear understanding that it is only part of a *system*, and that it must have and maintain an intimate, accurate relationship to the rest of the system.

The television receiver antenna is energized by the travelling waves, which cause corresponding currents to flow from the antenna to the receiver. The receiver is tuned to the particular frequencies to be received in order to maximize the ones desired, and to minimize undesired ones, just as in a sound receiver. These currents, even when turned in to maximum, are very small, and are fed into vacuum tubes to be amplified. After this operation they are large enough to operate a device designed to convert them into light images.

This device is called the "Kinescope,"* and is the inverse of the "Iconoscope"†. The "Kinescope" has a plate and a beam of electrons playing upon it, just as does the "Iconoscope." In the "Kinescope," however, the plate, or screen, is made differently; in fact, it is one end of the tube itself, made nearly flat, and coated on the inside with a very thin layer of material which has the property of flourescing, or giving off light, whenever electrons strike it. Some fluorescent materials will glow for a considerable time after being struck by electrons. The particular compound used for "Kinescopes" is chosen so that the glow dies out shortly after the electron beam moves away, and before it returns again.

The tiny electron beam in the "Kinescope," whenever it is not moving and therefore strikes the screen in one spot, causes a bright glowing spot on the screen at the point of contact. This spot is about the size of a pinhead. Although the glow is really on the inside of the tube, it is visible on the outside because the end of the tube is clear glass, and the screen of fluorescent material is very thin.

The brightness of the spot depends upon the strength of the electron beam, and varies as the strength of the beam is varied. That spot of light is used to reproduce each spot of the picture, one at a time, by moving it around all over the picture area. It must be moved in exactly the same way that the "Iconoscope" beam at the transmitter is moved, which in modern systems is in horizontal parallel lines from top to bottom.

Beam Moves 30 Times a Sec.

So this beam will be very, very busy, too. It is going to move all over the picture in regular fashion, and repeat the travel 30 times per second. Furthermore, while moving, it is going to vary in brightness continually as it "paints" the lights and shadows of each tiny element of the picture. To our slowly reacting human eyes, the *spot* will not be visible because it is moving so rapidly, and the screen will appear to be illuminated evenly all over the picture area; but we must remember that actually the light and the scenes are caused by one tiny spot of light flying over the screen and varying in brightness as it goes.

Much of the receiver apparatus is for controlling the movements of the beam, and feeding to it the currents which have been received from the transmitter, in order to vary the strength of the beam and therefore the brightness of the flying spot. Of course there are many engineering problems associated with this apparatus. The most interesting ones are those associated with what is called "synchronization," or the necessity of keeping the flying beam of the "Kinescope" in perfect step with the flying beam of the "Iconoscope," even though they may be miles apart with only a tenuous radio connection between.

Obviously these two must be kept together very accurately, even though they are moving very rapidly over the picture. It would not do at all to have the beam at the transmitter picking up the sparkle of highlight in the eye of the beautiful television lady artist, while the receiver beam was working where her nose was supposed to be.

Method of Scanning

The object to be attained may be stated simply. It is merely that the electron beams of the "Iconoscope" and the "Kinescope" are to be kept in perfect step with each other. Each is to travel across its plate or screen in horizontal lines. Each is to start at the upper left corner, let us say, move across the first or top line at the proper speed, quickly jump back to the left and start on the second line just below the first line, complete that, jump back for the third, and so on until it has covered all 441 lines, finishing at the lower right corner. Then it must jump up to the upper left corner and begin again on the top line.

Perhaps we should note here that the method of scanning actually used in modern systems does not move the spot in quite such a simple regular fashion, but has a more complex movement such as doing lines alternately, all the odd-numbered ones first, and then the even-numbered ones. This is known as "interlaced scanning" and provides several important technical refinements and benefits. It is not necessary to study this more complex method, however, to understand the basic fundamentals of the system, and we may assume that the beam travels over the picture from top to bottom, line after line progressively.

The beams in each case are made to move by magnetic fields produced by currents in coils mounted on the sides of the "Iconoscope" and "Kinescope." If the right currents are fed into these coils at the right times, the beams will move as desired. The currents can be obtained from vacuum tubes arranged as oscillators, but one beam is at the transmitter and one is at the receiver miles away. We must have these oscillators working absolutely together—because if they deliver their currents out of step by even as little as one one-

*Trade Mark Registered U. S. Patent Office.
†See I. P. for Dec., 1937, p. 11.

millionth part of a second, the reproduced image will have no likeness to the original. So they must be tied together somehow.

At present this is accomplished by making the generators of currents at the transmitter into masters of the situation. They are arranged to send out short timing signals, called synchronizing signals, and there are two of them, one for keeping the beams together horizontally, and one for keeping them together vertically. These signals are additional to the picture signals, so that a television transmitter sends out three different signals, one describing the picture, and two to keep the beams in step horizontally and vertically.

Of course, if they were all sent out simultaneously they would interfere with each other. Therefore the synchronizing signals are sent out very quickly during the short time intervals when the beams are not being used for the picture, but are occupied in jumping back from right to left preparatory to starting a new line of the picture. This means, in effect, that each receiver of all those which may be "looking-in," is continuously receiving instructions and assistance, from the transmitter, by means of which it is enabled to keep its "Kinescope" picture beam exactly in step with the scanning beam at the transmitter.

Synchronization is one of the television problems which has been solved, and it is a considerable triumph that we are able to control apparatus at a distance with a precision measured in *fractional millionths of a second!*

Avoid Servicing Problems

A problem of receivers in process of solution is that introduced by the necessity of making them so that they can be operated and adjusted satisfactorily by the general public without their having to take an educational course in television engineering. The television receiver is a complex instrument, far more so than present sound receivers. It includes a complete sound receiver to start with, to receive the sound which accompanies the picture. Beyond that are the circuits and tubes which tune and amplify the picture signals, the circuits and tubes which tune, amplify and utilize the two synchronizing signals, and the "Kinescope" tube with its associated circuits.

Many correct adjustments must be made before the picture can be viewed, and if too many of these are required of the operator, or those required are too critical, it will be impossible for the layman to operate the receiver satisfactorily. Therefore most of the adjustments must be accomplished automatically, and only a few left to the operator. This makes the receiver design more difficult, of course, but the status of progress toward solution is such today that is is possible to promise that when television receivers are put into public use, they will be sufficiently simple in operational requirements.

A problem always noticed by the layman is that of size of the reproduced picture at the receiver. At present there are two standard sizes, one about 5 by 7 inches, and the other about 7 by 10 inches. Scenes of any size can be televised by the transmitter merely by using the appropriate optical lens to focus them on the "Iconoscope." At the receiver, the size of the picture is determined definitely by the size of the screen on the "Kinescope." There is a limit of physical size beyond which it is impracticable either to build these tubes, or to house them in cabinets of reasonable size for the home.

Most Desirable Picture Size

It seems to be general experience that the most desirable size of picture for television or motion pictures is that where the height is about one-fourth the distance between the screen and the observer. Such a size seems to give the maximum of realism or emotional appeal. In the home, the desirable viewing distance is at least 8 or 10 feet, so that the picture height should preferably be at least 2 feet. There is good promise of eventual accomplishment of this goal, but at present it seems probable that the television receiver which is "just around the corner" will have a picture about 7 by 10 inches.

Often it is asked why this picture cannot be increased simply by optical means, with a lens to magnify it several times. This could be done insofar as size is concerned, but the brightness of the picture would suffer in proportion, or actually even more than in proportion, and the original amount of light available from the fluorescent screen is not enough to permit so much spreading out.

This matter is perhaps the most serious problem of television, at least from the user's viewpoint; but since it is true that the resources of Nature are infinite, and that we have only to find the way which exists somewhere, it seems definite that sooner or later even this difficult problem will be solved.

And now we have traversed the system, from the beginning where we had only imponderable light waves picked up and focussed by a camera lens, to the "Kinescope" screen, where the well-regimented electrons of a beam have produced an image on a fluorescent screen. A summary of the major problems encountered appears to be in order and may furnish an appropriate conclusion to this discussion.

Summary of Problems

Foremost among the problems is that of standardization. We have seen how intimately related the transmitter and receiver must be; consequently many receiver design features and many transmitter design features must be definitely related, and this must obtain whether the apparatus is made by one or any number of manufacturers. In sound receivers, this difficulty does not exist, and any receiver built by any manufacturer readily receives any station built by any manufacturer, with very little coordination. In television, many factors must be chosen, standardized, adopted, and maintained by all concerned, or the rest will be—no picture! If wrong choices were made, the art would be permanently handicapped. Therefore it has been necessary to proceed cautiously, and to make certain that decisions would stand the test of time.

The next most serious problems have been in the development of devices which would convert light to electricity and electricity back into light, in easily and accurately controllable fashion. The "Iconoscope" and the "Kinescope" have answered this need, but studies and experiments to improve them will continue.

The necessity of transmitting so much information in so short a time, in order to describe moving pictures electrically, has compelled the use of very high frequency currents and radio waves, much

(Continued on page 28)

The Kinescope, used in the RCA television reproducing apparatus

Projecting Hi- and Low-Range Prints; Standard Fader Setting Data

SINCE the advent of recorded sound to motion pictures there has been a continual improvement in the quality of sound recording and sound reproduction by extending the volume range to produce greater dramatic effect. Improvements in recording naturally require improvements in reproduction. Improvements in amplifiers permit a wider volume range, and the theatre reproducing apparatus must consequently be capable of transmitting this increased range.

Some of the recent developments in reproducing equipment include: the introduction of new design horns which give far better quality than was formerly possible, and a more even and adequate distribution of sound throughout the theatre auditorium; improvements in the film running mechanism which have reduced flutter to a minimum; and increased amplifier power, which will adequately reproduce without distortion the wider power ranges now being recorded on the film.

It is recognized in the studios that until such time as all theatres are fitted with modern equipment, methods must be adopted which allow the wider volume range films to be reproduced to their best advantage in those theatres having equipment capable of this reproduction, but which do not penalize those theatres fitted with reproducing equipment not capable of handling the wider volume range.

Track Area Limits Output

The film received in theatres has an output limited by the dimensions of the track. The maximum volume range, *i.e.*, the range from the faintest to the loudest sound which can be satisfactorily reproduced, is limited by the volume range

These data, reflecting important advances in the reproduction process, are promulgated by the Academy of M. P. Arts & Sciences following intensive application over a long period of time by its Committee on Standardization of Theatre Sound Projection Characteristics. Specifications covering fader setting instruction frames now become an integral part of the Standard Release Print, the indicia to appear in the space originally provided therefor.

Standard nomenclature for sound tracks will be described and illustrated in the next issue of I. P.

between surface noise and the total track sound output.

During the past year several of the major companies have, in a limited number of releases, made available to the theatres two general types of prints: one type being the "Regular" release print with the ordinary volume range, and the other type, divided into two classifications according to the volume range recorded on the film, known as "Hi-Range" and "Lo-Range" prints.

The "Hi-Range" prints, requiring increased amplifier power in the reproducing equipment, and having an approximate sound intensity range of 50 db, produce intensity changes which closely approximate those occurring in Nature. Musical passages so recorded and subsequently reproduced with adequate power, lend the added color and naturalness necessary to insure more complete enjoyment of the presentation.

Those productions released on "Hi-Range" prints will also be available on "Lo-Range" prints, the volume of which may correspond with the studio "Regular" prints, or may be recorded to play 3 or 4 db above the particular studio's average. (See Figures 5 and 6). In other words, any production issued on "Regular" prints will be distributed completely on one type of print, while any production available on "Hi-Range" prints will also necessarily be available on "Lo-Range" prints as well.

As more and more theatres are converted to the modern equipment capable of reproducing wider volume ranges, the practice of issuing "Hi-Range" and "Lo-Range" prints will undoubtedly be rapidly extended.

The success of such productions as "Maytime," "100 Men and a Girl," and other similar musical productions released on "Hi-Range" prints indicate that this type of release print has a definite place in the industry from a showmanship standpoint. A complete appreciation by the exhibitor of the technique required for their reproduction will insure still greater box-office success.

By means of improved technique in the studio, "Hi-Range" prints have a controlled balance of volume between dialogue and music; that is, relative reproduction between the dialogue and music has been predetermined by experienced showmen after careful consideration of the output level.

The sound volume reaching the ear of a patron from any given print projected at a certain fader setting depends upon the percentage modulation of the signal on the film. On "Regular" prints (projected at the average fader setting for any particular studio's product), both the dialogue and music are given 100% modulation a greater part of the time. This means that the output vol-

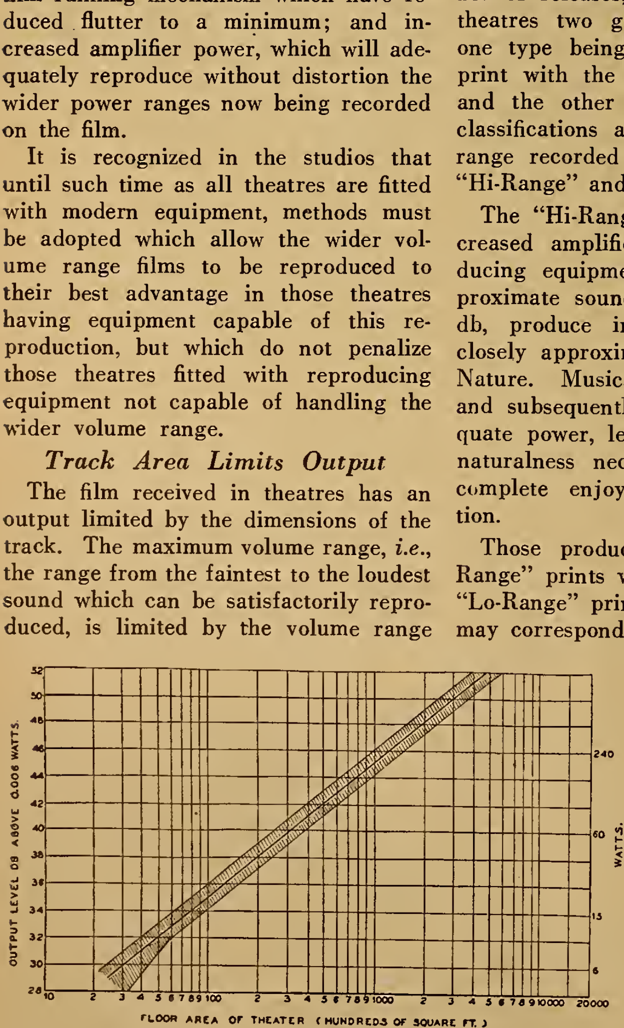


FIGURE 1
Recommended amplifier output in electric watts in terms of floor area

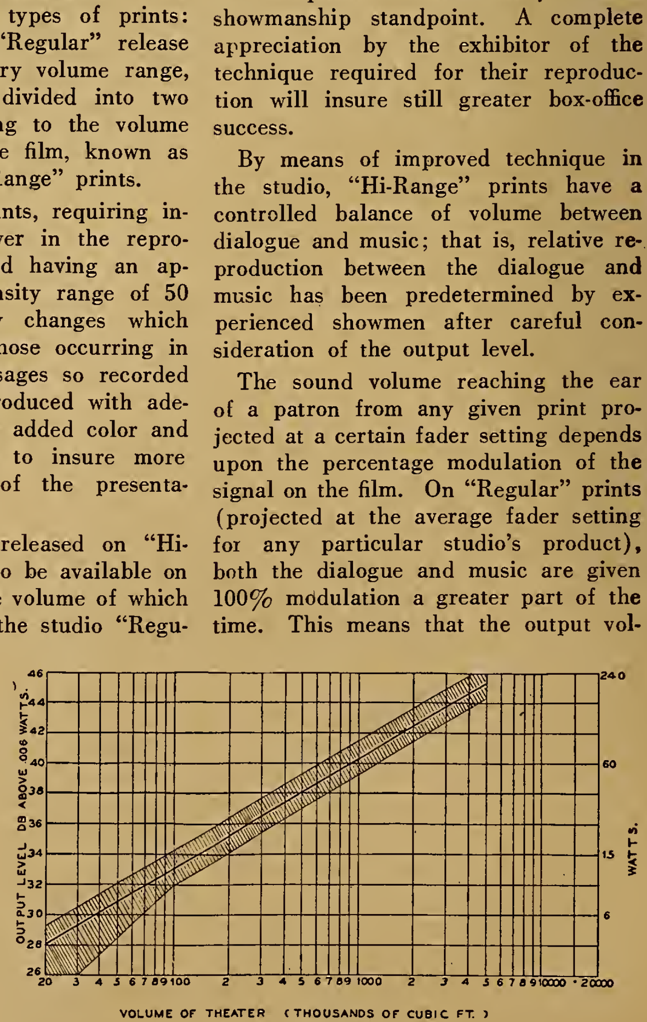


FIGURE 2
Recommended amplifier output in electric watts in terms of volume

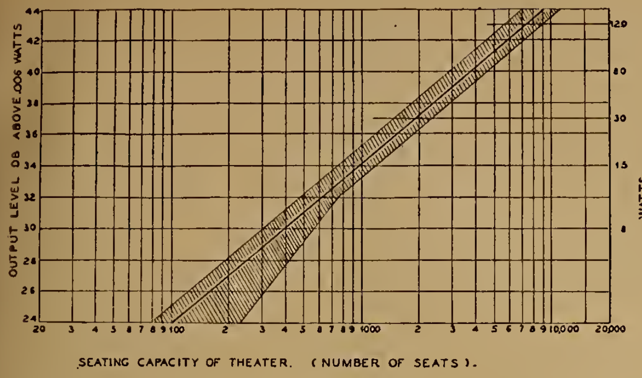


FIGURE 3

Recommended amplifier output in electric watts in terms of seating capacity

ume will be practically the same throughout the production.

In recording "Hi-Range" prints, however, most of the dialogue passages are intentionally reduced in modulation so that the average dialogue modulation rarely exceeds 50 per cent, while the music is recorded at 100 per cent modulation. This provides a volume differential between music and dialogue of at least 6 db. "Hi-Range" prints do not necessarily provide *louder* sound, but an extended volume range which gives more dramatic value in the theatre.

*When such a print is projected, the fader must be raised at least 6 db for proper dialogue volume.** To utilize this volume range on the film the theatre must necessarily be provided with an amplifier output which is increased by approximately the same range. Increased amplifier power is necessary since in the past the average theatre installation has had only sufficient power to reproduce dialogue satisfactorily. In general, those theatre installations equipped with modern loudspeaker systems have sufficient amplifier power to adequately reproduce this higher volume range.

By observation of a number of houses it has been found that a theatre containing up to 1,000 seats requires from 10 to 15 watts of power, from either the original old standard horn systems or the more modern two-way loudspeaker systems. Houses having from 1,000 to 2,000 seats require from 19 to 24 watts of power; and theatres with over 2,000 seats require at least 48 watts.

General Power Classifications

These general classifications will serve to determine the amount of power necessary for theatres with seating capacities as outlined above. However, in order to demonstrate the basis upon which these rules were formulated, there is included in this report several charts. These charts indicate the theoretical minimum requirements for a theatre of any given size or seating capacity, while the information in the paragraph above is based upon combinations of amplifier equipment actually available commercially at the present time.

Figure 1 shows the recommended amplifier power output in terms of the theatre floor area; Fig. 2 in terms of the cubical contents of the theatre; Fig. 3 in terms of the number of seats installed.

These curves indicate the necessary amplifier capacity to maintain a high quality sound reproduction, but since the required power is partially dependent upon the absorption and reverberation characteristics of the theatre auditorium, deviation from these values may be required, depending upon the variation of any particular theatre from optimum reverberation conditions.

In reproducing a high-volume print, the theatre manager and projectionist should follow the usual method of setting the fader for proper dialogue volume, which will automatically insure a proper reproduced volume level for any musical or sound effects passages in the same production. *If the volume level of the music or sound effects is reduced to a point lower than that originally intended at the time of the recording, dialogue passages will be too low for satisfactory reproduction.*

It might be pointed out that sound recorded for motion pictures in the studios today is recorded so that in general it may be projected in the theatre on one fader setting throughout the entire production. Although this is the general aim in each studio sound department, it may not be possible to project an entire production or an entire reel at one identical fader setting, due to the fact that release prints are often damaged and replacement sections must be inserted from time to time which may not be processed exactly as is the original print, or because there may be variations in the processing of the original prints.

If the equipment is not functioning properly, or if there is insufficient power capacity, the higher volume portions of the musical passages will reproduce with harshness and distortion.

When such prints are reproduced on the older-type theatre systems, the increase in amplification necessary to properly reproduce the high volume passages will sometimes introduce objectionable hum and other system noises which can usually be eliminated by care-

* See data under heading of "Standard Fader Setting Instruction Leader."

FIGURE 4

Specifications for Standard Release Print leader, showing location of standard fader setting instructions. (For other data on motor and change-over cue, and reel end leader, see complete specs. for 35 mm. release prints, previously published).

Protective Leader

Shall be either transparent or raw stock.
When the protective leader has been reduced to a length of six feet it is to be restored to a length of eight feet

Identification Leader (Part Title)

Shall contain 24 frames in each of which is plainly printed in black letters on white background: (a) type of print, (b) reel number (Arabic numeral not less than 1/4 of frame height), and (c) picture title.

Synchronizing Leader

Shall consist of 20 frames ahead of Start mark, then 12 feet, including Start mark, to picture, opaque except as specified below: In the center of the first frame there shall be printed across the picture and sound track area a white line 1/32 inch wide upon which is superimposed a diamond 1/8 inch high.

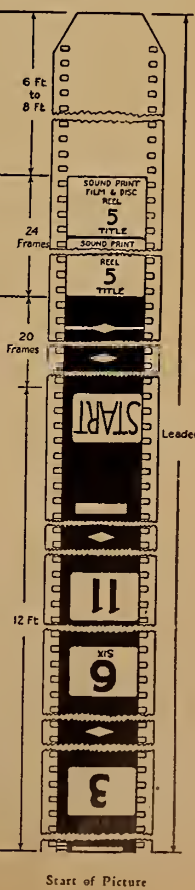
The next 15 frames may be used by the studio for sensitometric or other information. If not so used this leader shall be opaque.

The Start mark shall be the 21st frame, in which is printed START (inverted) in black letters on white background. The Academy camera aperture height of .631 inch shall be used in the photography of this frame, and all others between Start mark and beginning of picture.

From the Start mark to the picture the leader shall contain frame lines which do not cross sound track area.

In the frames in which the numerals "6" and "9" appear, the words "six" and "nine" (also inverted) shall be placed immediately below the figure, to eliminate the possibility of mis-reading in the projection room due to the similarity between the inverted numerals.

Beginning 3 feet from the first frame of picture, each foot is to be plainly marked by a transparent frame containing an inverted black numeral at least 1/2 frame in height. Footage indicator numerals shall run consecutively from 3 to 11, inclusive. At a point exactly 20 frames ahead of the center of each footage numeral frame there shall be a diamond (white on black background) 1/8 inch high by 3/4 inch wide.



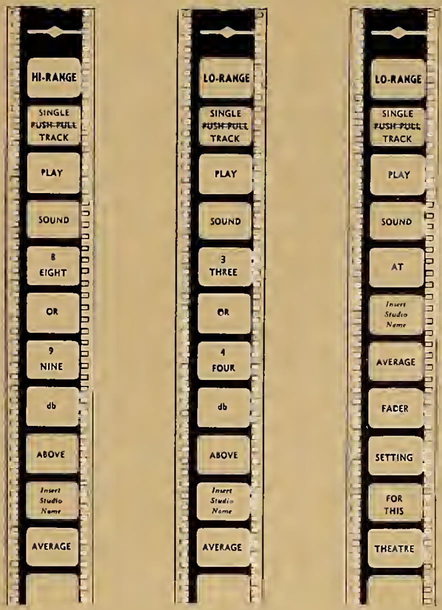


FIGURE 5

Standard fader instruction leaders

ful adjustment or modification of the system.

The use of the higher amplifier power necessary to reproduce these prints also requires that the distribution of sound throughout the theatre be particularly uniform. In this type reproduction, flutter due to poor motion of film through the sound head, if present, will be particularly noticeable.

In order to assist projectionists, as well as the exchanges, in quickly identifying the "Hi-Range" and "Lo-Range," as well as "Regular" prints, each of the major studios will, effective immediately, label each print "Hi-Range" or "Lo-Range," or "Regular," and designate a general average fader setting at which the print should be projected—this information to be included in the Standard Release Print Leader on each reel of each production, in accordance with specifications outlined under the succeeding heading.

It is suggested that all theatre projectionists carefully watch every print in order to take advantage of this additional information which should assist in increasing the showmanship value of recorded sound.

S. R. P. Fader Setting Instruction Leader

TO FURTHER aid in the proper handling of "Hi-Range" prints the studios are now utilizing that part of the Standard Release Print leader which has been designated for use for any pertinent information to be transmitted from studio to theatre. A portion of the specifications for the S. R. P. leader indicating the location of this instructional information, is shown in Fig. 4, with details of the information to be known as "Standard Fader Setting Instructions" illustrated in Figs. 5 and 6.

The Standard Fader Setting Instruction leader shall consist of 15 frames located as specified S. R. P. leader) in the synchronizing leader; the first frame shall designate the type of print; the second frame the type of reproducing equipment necessary to project the print; and the next nine frames the general fader setting specified in relation to an average fader setting for the particular product under consideration. The remaining frames may be used for whatever additional information the studio may wish to transmit to the theatre.

This instruction leader will be of assistance to the exchange in that it will facilitate the special handling required in the exchange for the various types of prints, by providing an easily noted means of identification for each type.

Various Designations on Prints

It should be noted that the designation "Regular" in the Fader Setting Instruction Leader indicates that only one type print has been issued on the particular production under consideration. Productions with prints designated as either "Hi-Range" or "Lo-Range" will have been issued in both type prints, *i.e.*, all productions on "Hi-Range" prints will have necessarily been issued on "Lo-Range" prints as well

This instruction leader will also enable the projectionist to identify a print which requires a "push-pull" reproducing system as contrasted with a print requiring a "single" system.

Lab. Strikes Out 1 Term

In order to identify more plainly the "push-pull" or "single" system prints, it was decided to include both the terms "push-pull" and "single" on every leader, crossing out in the laboratory

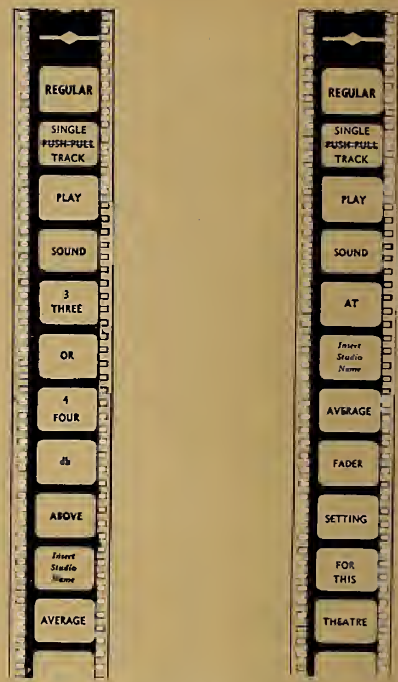


FIGURE 6

Standard fader instruction leaders

one or the other of these two to leave the appropriate term designating the type sound track on the print. The illustration of the Instruction Leader in 5 and 6 indicates the manner by which this was accomplished for leaders which would be included in prints containing a sound track for reproduction on a "single" system. For leaders to be included in prints containing "push-pull" tracks the word "single" would have been crossed out, leaving the word "push-pull" to indicate this type of track.

In order that the projectionist may achieve the best results, the fader setting designated in this leader should be followed in general, inasmuch as the entire balance between the dialogue and music throughout the reel will be chosen for each designated setting.

News Notes

THE I. A. was much in the news of the past month. First, the five studio locals voted overwhelmingly in favor of I. A. General Office supervision for an indefinite period. I. A. and RCA finally agreed on a contract covering all RCA theatre servicemen in a deal similar to that closed recently between I. A. and Altec.

Society of Sound Engineers, unaffiliated N. Y. City group, wired President Green of A. F. of L. and asked why I. A. had refused them a charter; why I. A. has signed contracts covering theatre sound service without consulting the engineers, and why I. A. seeks to destroy Society by allocating several servicemen to each I. A. local.

All-Canadian Labor Congress, opposed to A. F. of L. units in Canada, charged that I. A. forced cancellation of all road stage attractions in a Canadian theatre because I. A. men were not employed therein. Excerpt from petition to Canadian government:

"Surely it is not too much to ask the government to find some means whereby it can protect the right of Canadian workers to establish and maintain their own independent unions. Members of United States unions who are permitted to enter Canada to fulfill engagements here do so by the grace of the government, and if they use boycotts or sit-down strikes in the attempt to destroy Canadian unions, it is not unreasonable to suggest that the government is bound to take cognizance of such activities."

Poor Canadian Prints

Canadian exhibitors, on the warpath over the poor condition of film prints, have named a Better Prints Committee.

Complaint covers scratches, sprocket holes and poor splices. Exhibs assert too few prints are in circulation, with subsequent runs getting the worst of it.

Canadian motion picture theatres have increased by 227 to a total of 1,089 in 1937, with majority of new houses being under 500 seats.

S.M.P.E. Washington Convention

The next convention of the S. M. P. E. will be held at the Wardman Park Hotel in Washington, D. C., April 25-28. The Fall meeting is scheduled for Detroit sometime in October.

17,000 Active U. S. Theatres

There are 17,000 active theatres in the U. S., according to film czar Will Hays. Approximately 740 new theatres were opened during 1937. Hays estimated theatre attendance at 12 million daily, reflecting a weekly gain during 1937 of 1 million patrons. Picture business has a capital investment of 2 billion dollars.

N. Y. State 2-Men Bill

N. Y. State Federation of Labor will handle and push aggressively in N. Y. Legislature bill compelling all theatres in State to employ not less than two men on each shift. Labor is very strong in legislation right now, thus chances for passage of manpower measure are bright.

A. P. S. Installs New Officers

Annual meeting of American Projection Society on Jan. 10 witnessed installation of new officers by P. A. McGuire, honorary member of Society. Executive roster now is W. Byrne, pres.; A. R. Bishop, v.p.; Frank McMahon, sec.; T. Rugino, treas.; and J. Chulchian, sgt. at arms. Governors are J. Burgundy, A. Polin, B. Norton, T. D. Smith, H. Levene, and H. Grabelsky.

Barrows-Burke 20th Term

Thad Barrows and Jimmy Burke have been re-elected as president and business representative, respectively, marking twenty years service by these men in same posts. Other officers B. McGaffigan, v.p.; A. Moulton, fin. sec.; J. Rosen, treas., and an executive board of L. Pirovano, J. Nuzzolo, and J. Gibbons.

Altec-RCA Service Control

Recent acquisitions by RCA and Altec of so-called independent theatre servicing groups throughout the country indicates that these two I. A.-organized outfits intend to stand alone in the theatre servicing field. I. A. can, and probably will, assist materially in this drive by barring from unionized theatres all non-union servicemen. Naturally, no exhibitor can be forced to take service that he doesn't want, but number of these is few, the result of the sharp drop in service rates during the past few years.

Loew's, 20th Century Profits

Two major film companies show healthy statements for their last fiscal years. Loew's, Inc., had net earnings of $14,426,062 after all charges, equal

to $8.62 a share on outstanding common stock. Net earnings for 20th Century-Fox approximate $10,000,000, with current year expected to be better.

Hit Stars Radio P.A.'s

The appearance of film stars on radio programs throughout the week is a far more serious matter to the picture business than are horse and dog tracks and other events which compete with the theatre for patronage, according to Jack Cohn, vice-president of Columbia Pictures Corp. The Third (N.E.) District of the I. A. recently expressed its opposition to pari-mutuel betting.

Cohn said that film stars on the air place the movie industry in the position of having to sell that which the radio gives away—entertainment. Exhibitors generally are burning over these air appearances, but producers not only will go along with their exhibitor customers but actually compete with each other in sponsoring big radio shows.

Radio executives attitude is that picture industry should stop "fussing" about film players on the air and be grateful for all the publicity accorded pictures by air shows.

TELEVISION PROBLEMS: A DESCRIPTION FOR LAYMEN

(*Continued from page* 23)

higher than used in previous radio services. This has required development of new tubes and circuits to generate, amplify and control them. It has required the study of their behavior in space, so that we could know how far and with what results these new waves would travel.

The problem of synchronizing the receiver with the transmitter has been difficult. It has been solved, but to obtain the solution has required extraordinary amounts of research, patience, ingenuity, time and money.

The problem of network connection of stations, *to permit syndication of a program, remains to be solved.* Various problems of economic sort having to do with location and cost of stations, and programs, are dependent upon this technical problem.

The problem of increasing the size of the reproduced picture in the receiver still is with us. We expect to solve it, and we probably will. But if we do not, we may well be grateful and content that clear vision of distant events has been given to us, even if not quite as conveniently sized as we might like.

There is one problem which is not an engineering one, strictly speaking, although there is close mutual dependence between it and technical developments. This is the program or studio requirement. No matter how excellent the technical facilities may be, the whole system is a loss if those things put before the "Iconoscope" are not interesting to the watchers at the "Kinescope." Whenever a new technical service is provided, time is required to find out how to use it. Its strong points and its weak points have to be discovered by experience—the former capitalized and the latter avoided.

If television had come to a world which knew nothing of sound broadcasting or of motion pictures, any kind of program material, no matter how poor, would have been acceptable initially, and improvement in program to good standards might have been allowed to take considerable time. But television will come to a world already accustomed to

reproduction of sound and pictures having very high program excellence and effectiveness. If the television receiver is to have interest longer than a few days after its purchase, the program it delivers must supply the interest. Therefore it is necessary to solve the studio problems of television—the lighting, make-up, costuming, scenery, scenarios, actors, and all the rest—before television can be made a public service.

Place in Amusement Field

Questions are often asked concerning the possible effect of television upon sound broadcasting and sound motion pictures. The answer is simple, and the gift of prophecy is not needed in order to be able to make it. The answer is apparent from the outcome of many similar situations in the past. The telephone did not supplant the telegraph; it supplemented it. We still have messages to transmit which do not require person-to-person conversation. The telegraph cannot serve as telephone, but neither can the telephone do things which the telegraph can.

Similarly, sound broadcasting did not ruin the theatre and the motion picture. Instead it added to their appeal and their profits. At first there were many fears. Opera managers would not permit performances to be broadcast. Boxing promoters would not permit their fights to be heard over the air. But after things settled down, the actual results were—the million-dollar boxing gate, the S. R. O. sign in opera houses, the addition of sound to the motion picture, and increased public interest in the theatre generally.

And so it will be with television, no matter how excellently that develops in years to come. There will be some things which television can do which previous arts could not do, a few things which it can do better, but there will be many things which they can continue to do which television cannot do at all. So they will continue, and we shall have added another art and public service to the continually growing list. As a matter of fact, rather than being harmed by television, many of the older services are going to be helped, just as the silent motion picture was enabled by radio sound apparatus to find its voice and expand its possibilities. The older arts will find much help from the gadgets of television, should therefore welcome it, and need not fear it.

The Pressing Question: When?

Only one problem remains to mention. It is one which is encountered by television workers more frequently than any other. It is the question "When will we have television?" That is one problem which has *not* been solved! A simple answer is not possible, because the question is not simple without several definitions. We have television right *now*, under the definition of technical possibility. We will probably have it in a year or two if we limit the definition to include only those people who live within a few miles of a station, with only two or three stations in the country.

However, if we mean when will television service be available to most of the people of the country, it seems safe to say that the years between then and now will be goodly in number.

ANALYSES OF NEW THEATRE REPRODUCING EQUIPMENT

(*Continued from page* 19)

grid and the plate. The suppressor grid is tied to the cathode, either internally or at the socket, and therefore is positive compared with an electron, although commonly thought of as negative because it is negative compared with the screen grid and plate. Its presence discourages secondary emission from the plate, where the screen, unshielded by a suppressor, had the opposite effect. The five-element tube, or pentode, built in this way, is capable of enormous ampli-

fication as compared with the simple triode.

These considerations may lead some to think that introduction of gas, which also increases the value of the space current, might promote amplification, but such is not the case. The action of the gas depends upon the motion of the gas ions—atoms that have lost one or more electrons. Ions are extremely heavy compared with electrons, 1800 times as heavy at the very least. Their weight or mass prevents them from reacting easily to the slight, quick changes of grid voltage that represent audio frequencies.

Increased plate current due to the presence of gas is not accompanied by increased amplification, and elaborate and rigid processing is used in the manufacture of amplifying tubes to keep gas out of them. Among other things, the metal parts are heated to incandescence, and the glass almost to the point of fusing, to drive occluded gasses out of those materials before the pumping stops and the vacuum is sealed.

The type of amplification described, in which the grid carries a permanent negative bias which is varied to a slight degree by the input pulsations, is Class A amplification.

In Class B circuits the permanent grid bias is either zero or very low. Thus, when the incoming pulsation is negative the grid bias is increased; but at the positive input swing the signal voltage is stronger than the permanent bias (if any) and the grid goes positive. The result is an immense temporary increase in space current, as the grid attracts emission instead of repelling it. Some of the electrons are captured by the grid, resulting in a flow of actual grid current, but the majority go on to the plate, constituting a sudden surge that represents enormous amplification.

In these circuits, the fact that the grid attracts electrons at some parts of the cycle, and carries real current, means that it cannot be coupled to the signal source through a high resistance. Also, the signal source cannot be a voltage amplifier; the grid must be supplied with current as well as with voltage, hence with power. The signal source for a Class B amplifier or stage of amplification is called a driver amplifier or stage, and in a theatre system may have an output of several watts.

Class B amplification is seldom very free from distortion, and a compromise arrangement is known as Class AB. The grid carries a permanent negative bias of moderate value. As long as the volume remains low, the amplifier works essentially as a Class A circuit, in which the input signal is up or down, but never to the point where the grid becomes positive. However, when the signal volume increases, the input may overcome the grid bias completely, swinging the grid positive and resulting in Class B operation.

This arrangement has a number of advantages. The relative freedom from

distortion characteristics of Class A is obtained at all lower volume levels, which is where distortion is most noticeable. When sound is very loud, distortion is more difficult to distinguish. At the same time a smaller, cheaper amplifier is made capable of putting out volume that would require larger tubes and parts if the operation were maintained at Class A under all circumstances.

In a Class A circuit the grid is biased at a point at which no signal will ever be strong enough to overcome the permanent voltage and drive the grid positive. However, unexpectedly strong signals may upset this anticipation, causing a Class A grid to draw current and work temporarily as Class B. When this happens the plate current meter fluctuates visibly, and the amplifier is said to be overloaded. It is also in some danger of burning out, since its parts are not designed to carry the resultant surges of plate current.

S.M.P.E. Discussion of Stereoscopic Pictures

(*Continued from page* 13)

defects of registration and eye-strain go hand-in-hand.

Mr. Wheelwright: Some eyes are better stereoscopically and stronger than others. I am trained to use my eyes to such an extent that I am a very poor guinea pig to try the pictures on. People with sensitive eyes, or who use one eye to the exclusion of the other, are very much more conscious of eye-strain than I. I can assure you that pictures can be properly taken and can be properly shown so there is no eye-strain.

Mr. Freedman: When I tilted my head to one side, the registration became accurate.

Mr. Wheelwright: That is correct. The reason was that the planes of polarization are fixed as regards the projector, but you change the planes of polarization of the glasses when you tilt your head. The effect can be overcome by another method of polarization into which I do not now care to go.

Mr. Griffin: Mr. Wheelwright's paper sketched the history of stereoscopic systems. We might include therein mention of the "Teleview" system, which did not require audience to wear glasses. The system was installed in the Selwyn Theatre, New York, about 17 years ago. It projected two-eye pictures from two projectors running synchronously, the unit driving the projector motors being connected through a distributor driving small synchronous shutters connected to the seats for each viewer. The shutter cut-off alternately the left- and right-eye pictures so that the results were identical with those we are getting here.

Mr. Kellogg: How good is the screen in preserving the polarization? Can you scatter the light as much as needed without loss of polarization? What is the tolerance, or how much must the image for the wrong eye be reduced for practical purposes? How does the effect depend upon the general illumination level? It seemed to me as if some of the figures were distinctly out in front of the screen.

Mr. Wheelwright: If the screen has a metallic surface, or certain other surfaces that are satisfactory, there will be no loss of polarization. Certain other surfaces are completely unsatisfactory. For example, a plain white surface is very bad; an aluminum screen is practically perfect. There are all sorts of variations between.

Mr. Kellogg: To what extent must you suppress the unwanted image?

Mr. Wheelwright: Fairly completely, depending upon the lights and darks in adjacent areas. In other words, if a picture is of the same order of brightness throughout, then polarization will have to be very complete. In these pictures it is fairly complete, provided you hold your head substantially parallel to the projector, which most persons do by choice to get the best registration. That is the secondary problem, since we know a way of getting around it completely if it seems to be a serious problem.

Mr. Kellogg: Presumably the higher the level of illumination, the more exacting the requirements for suppression.

Mr. Wheelwright: That is right, and the greater the differences. The out-in-front effect is controllable at will. In some of these pictures it is being shown to a greater degree than I should have chosen. We know the laws now well enough to control it, and in making a commercial or semi-commercial film we can completely control

whether it occurs in front or in the background, or to what degree.

Mr. Kellogg: Does the out-in-front effect depend upon the distance of the observer from the screen?

Mr. Wheelwright: To a minor degree. If you sit very far back from the screen the depths are exaggerated. If you are very, very close, there is a sense of intimacy, but not so much depth as would be seen from way back. From the side, as long as each eye sees substantially the same brilliancy as the other, you will get a better sense of reality in the pictures than in a normal flat picture, wherein everything becomes distorted when viewed from a point at the side. We can control that with the metallizing of the screen, something we have been studying on the side. There has to be some metal in the base of the screen.

Mr. Mole: Have enough persons viewed these pictures to provide statistical information on possible anomalies in vision? I noticed, for example, what may be an individual idiosyncrasy, though nobody commented upon it—a secondary image off to the side of the screen.

Mr. Wheelwright: That is what might be called a vignetting problem. Since these pictures were taken and this projector built, the effect has been completely eliminated.

Mr. Schultz: I noticed when looking through these glasses that a great deal of light seemed to be lost. Have you information on the proportion lost, or is it that the glasses are imperfect?

Mr. Wheelwright: That is not because the glasses are imperfect; that is the penalty we pay for polarization.

Mr. Schultz: Would the average theatre be required to increase its screen illumination?

Mr. Wheelwright: Something would have to be done about the problem.

Mr. Friedl: You stated that the surface of the screen must be metallic. Ordinarily, I regard reflections of non-polarized light from metallic surfaces to be partially polarized. If in projection you use polarized light, will not the reflection from the screen depolarize it?

Mr. Wheelwright: Polarized light can be scattered to a great degree and remain polarized, or it can be reflected from a surface and still retain some degree of polarization. There is a difference in reflection from metallic and non-metallic surfaces. To retain polarization to a great degree the surface must be metallic or partly so. Fabric surfaces destroy the effect, depending upon the pigment and texture of surface. It is quite complicated.

Mr. Lewis: Can stereoscopic pictures be shown in the usual projector?

Mr. Wheelwright: Yes, with a supplementary lens or device in front of the lens.

Mr. Lewis: Is it not necessary to reduce the picture width, as shown here?

Mr. Wheelwright: As I mentioned, this equipment is experimental. There is no reason why the frame shape should not be the same. There will, however, be less film area per eyeview than there would be with ordinary pictures; but if you take the two eye pictures and add them up, there will be the same amount of information for the two eyes as before, but subdivided in a new way.

Mr. Lewis: If you used the standard 35-mm. projector and projected the pictures in the same size of room, would you have to reduce the area of the picture?

Mr. Wheelwright: In very large-sized projection you certainly would have to reduce the picture or increase the light. In the smaller pictures we think we can get away with it.

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TRADE MARK REG'D

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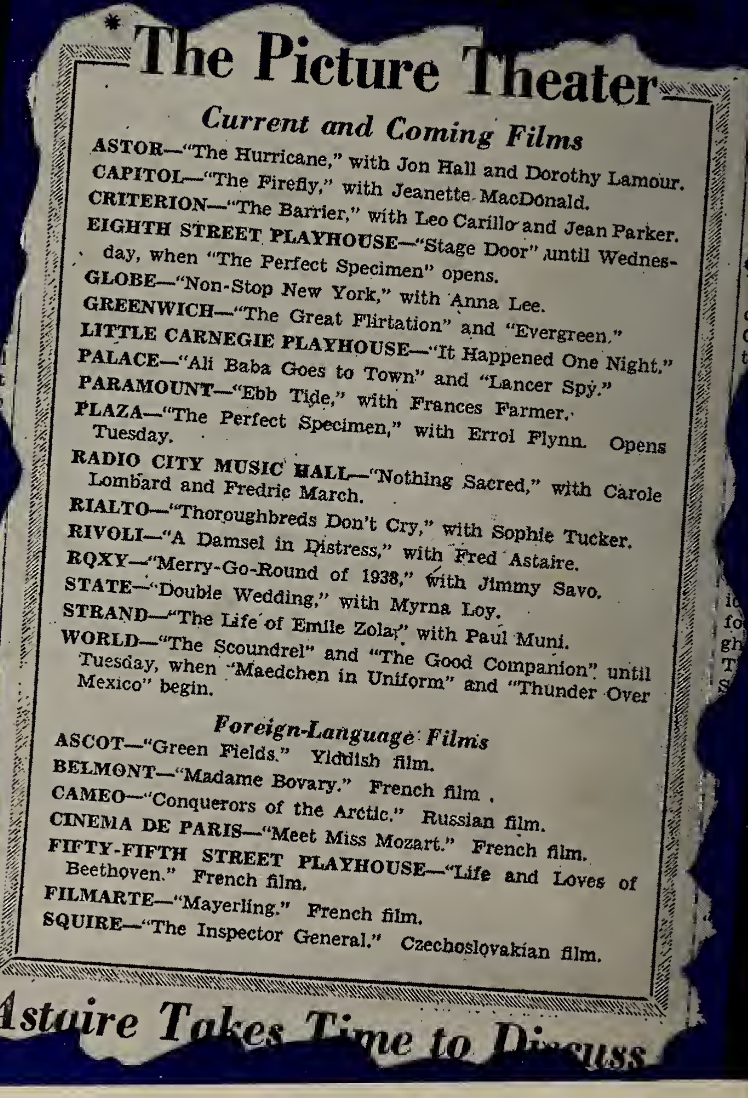

*The Picture Theater

Current and Coming Films

ASTOR—"The Hurricane," with Jon Hall and Dorothy Lamour.
CAPITOL—"The Firefly," with Jeanette MacDonald.
CRITERION—"The Barrier," with Leo Carillo and Jean Parker.
EIGHTH STREET PLAYHOUSE—"Stage Door" until Wednesday, when "The Perfect Specimen" opens.
GLOBE—"Non-Stop New York," with Anna Lee.
GREENWICH—"The Great Flirtation" and "Evergreen."
LITTLE CARNEGIE PLAYHOUSE—"It Happened One Night."
PALACE—"Ali Baba Goes to Town" and "Lancer Spy."
PARAMOUNT—"Ebb Tide," with Frances Farmer.
PLAZA—"The Perfect Specimen," with Errol Flynn. Opens Tuesday.
RADIO CITY MUSIC HALL—"Nothing Sacred," with Carole Lombard and Fredric March.
RIALTO—"Thoroughbreds Don't Cry," with Sophie Tucker.
RIVOLI—"A Damsel in Distress," with Fred Astaire.
ROXY—"Merry-Go-Round of 1938," with Jimmy Savo.
STATE—"Double Wedding," with Myrna Loy.
STRAND—"The Life of Emile Zola," with Paul Muni.
WORLD—"The Scoundrel" and "The Good Companion" until Tuesday, when "Maedchen in Uniform" and "Thunder Over Mexico" begin.

Foreign-Language Films

ASCOT—"Green Fields." Yiddish film.
BELMONT—"Madame Bovary." French film.
CAMEO—"Conquerors of the Arctic." Russian film.
CINEMA DE PARIS—"Meet Miss Mozart." French film.
FIFTY-FIFTH STREET PLAYHOUSE—"Life and Loves of Beethoven." French film.
FILMARTE—"Mayerling." French film.
SQUIRE—"The Inspector General." Czechoslovakian film.

Astaire Takes Time to Discuss

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PROJECTIONIST

FEBRUARY 1938

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With Which is Combined PROJECTION ENGINEERING

Edited by James J. Finn

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MONTHLY CHAT

THIS month we take leave of the so-called big fellows stationed in the larger theatres (these worthies being well able to take care of themselves) to point without pride to and view with considerable alarm a situation which is the peculiar concern of those projectionists (and owners and managers) who man the medium- and small-size theatres of this country—nay, of the world. Credit a lamp manufacturer for starting us out on this tack.

We received our first shock when informed that a. c. arc lamps still are being shipped, and in no minute quantities, to theatres everywhere. This news was somewhat of a blow to our pride, because we thought that this trinket had been decently interred for lo, these many moons. But no; and who are we to question on-the-level shipping records? Well, there might be some excuse for the purchase of a. c. lamps after all, even if only on the score of economy through ducking the purchase of converting equipment.

BUT the shock to end all shocks was yet to come. Our informant next proceeded to cite the shipping records on low-intensity lamps, orders for which were placed even after the strongest pressure in favor of Suprex had been exerted. This finished us, even if the next announcement were to be that 700 Edison Kinetoscopes had been installed in the U. S. within the last three weeks.

Now, we are not unaware of the fact that certain projection men profess to a strong dislike for the Suprex arc, although we have never been able to pry loose from these fellers their reasons therefor. We're quite willing to let it pass on the basis that these reasons are private and personal. But when the answer turns out to be preferment of the low-intensity arc over the Suprex, then it is high time, as they say in letters to editors, that something was done about it. So say we, too.

Irrespective of what yardstick is employed—whether it be quantity or quality of screen illumination, or lumens per dollar of cost, or suitability for color film—Suprex leads low-intensity by several hundred miles. Lives there a projectionist so dense as to be unable to recognize Suprex superiority over the l. i. arc? Supply dealers, we hold, have done a not-too-good job with Suprex; but we should be mortified to find one of our fellows voting for the l. i. arc.

SOAK up the data on that new Simplex E-7 which is described in word and picture within this issue. We couldn't hope to cover all angles of this unit in one fell swoop, so if there are any questions popping, let's have 'em. A new model projector is one of those rare events, its introductory period the one time we can snitch all the dope we want.

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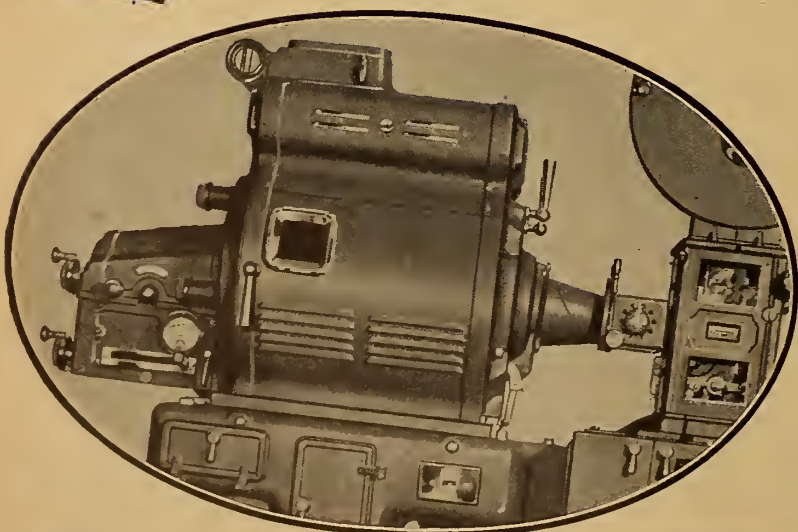

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INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 2

FEBRUARY 1938

Craft Tricks and Troubles of the B. S.* Projection Era

By *A. C. SCHROEDER*

MEMBER, PROJECTIONIST UNION 150, LOS ANGELES, CALIFORNIA

SOME of us like to gab about our early projection experiences, days when our projection knowledge was quite limited. Younger projectionists either listen in wonderment and with envy to the stories of the past, or they scoff, saying it is just "hooey."

Old-timers remember the small lamps we had and how the carbons grounded against the top or the floor of the housing. The arc was right off the line through a rheostat (unless the supply was a.c. when the rheostat might be replaced by a transformer). Everything in Los Angeles was Edison three-wire, thus on one side of the line the lower carbon grounded; on the other side the upper carbon grounded. The lamphouse roof was sometimes lined with mica to prevent the upper carbon grounding. Probably this is why the Powers 6-A had a much taller lamphouse and also the extended part on the lower front wall, giving more room so the lower carbon could not contact it.

***We haven't inquired of the author as to the reason for this flight of reminiscence, but we suspect that it was induced by the barrage of brickbats thrown in his direction by those who were nettled by his reference last month to "button-pushers" and his commendation of the up-and-coming younger craftsmen. (See article "As One Old-Timer to Another" on page 23.) Anyhow, the oldsters will read this with keen appreciation; while the youngsters —well, they just won't be able to imagine such goings-on.*—Editor.**

We used to fuss with the adjustment (so-called) for aligning the carbons on the Powers 6. Adjustments were not brought out of the lamphouse, but were right at the burner, and were adjusted when trimming the lamp. Loosening a brass knob, which clamped the adjustment, we moved the knob back or forth, swinging the top carbon into alignment with the lower carbon. The knob was then tightened, holding the carbons in line. Oh, yeah? It would, if the lamp were perfect, but most of them were soon junk, and the carbons quickly became misaligned. We then opened the lamphouse, and with pliers in one hand (remember the other hand was turning the crank!) we again aligned the carbons.

The adjusting screw was hot, electrically, and hotter than blazes otherwise. The light was blinding, so we could not see what was going on. We could only guess, then wait till the crater formed again to see if the spot was round. Those were the good old days.

Tricky Carbon Adjustments

We "saved" carbons even that far back, and sometimes ran short. At other times we had sufficient carbon in the lamp, but most of it was above the upper jaw, or below the lower jaw; we forgot to shift the carbons. With one hand

*Before sound. (As though you didn't know.)

still on the crank, the arc was lengthened as much as possible (which was quite a bit on a 110-volt line); the upper carbon clamp screw was loosened until the car-

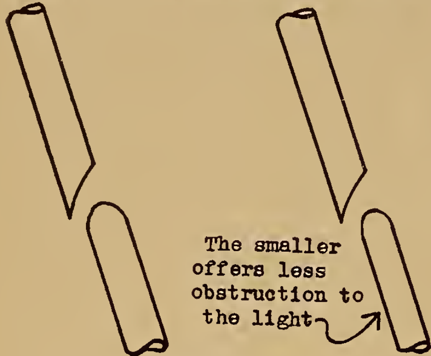


FIGURE 1

bon dropped of its own weight, then the screw was tightened and the arc adjusted to the proper length. When the carbon dropped it went down until it hit the lower one, and the light on the screen was practically nil for a few seconds.

Raising the lower carbon was more tricky. The clamp screw was loosened slightly, so the carbon could slide when twisted with pliers and pulled upward. The entire lamp being loose and wobbly, the spot at the aperture wandered around and the picture was poorly illuminated during the operation. After this procedure one's left hand was often blistered from the heat.

Edison and Bio were the only carbons, at least on the Pacific Coast, and the size was usually 5/8 inch. The same carbons were used above and below (positive and negative to you). Eventually the silver-tip carbon appeared. With one of these carbons in the lower jaw, we had an arc that did not sputter. Younger projectionists cannot realize what this meant. With the old carbons the arc would sputter if it was burned too short or too long, or if the alignment shifted slightly, which it often did.

Many attempts were made to improve conditions and obtain more light. Instead of a 5/8-inch carbon, considered standard, a 1/2-inch carbon sometimes was used below. This steadied the arc

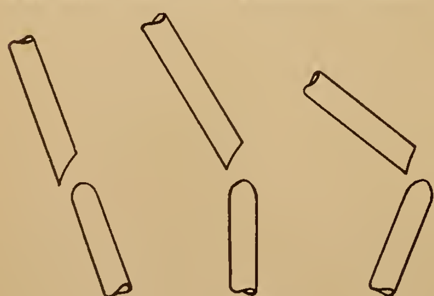


FIGURE 2

and often produced more light, due to less obstruction by the smaller carbon, as shown in Fig. 1. A solid carbon was also tried below, that is, a carbon without a core. However, the silver-tip stopped all that. Incidentally, the silver-tip was the forerunner of the coated carbon of today.

Figure 2 shows other attempts to improve the arc and the light, showing different relations of the carbons to each other. Each set-up had its adherents, who vigorously backed their method against any other. Fig. 3 shows further variations, the arc as a whole being tilted at different angles, with consequent advantages and disadvantages.

Versatile Projection Veterans

During the days when we cranked projectors we became very proficient with the free hand. Some projectionists wonder how a film can be spliced with one hand. The ends are carefully aligned on the bench, weights being used to keep them in position. It is surprising how rapidly and easily this is done with one hand, after a few years of practice. Fig. 4 shows the film with a weight on each end. The emulsion

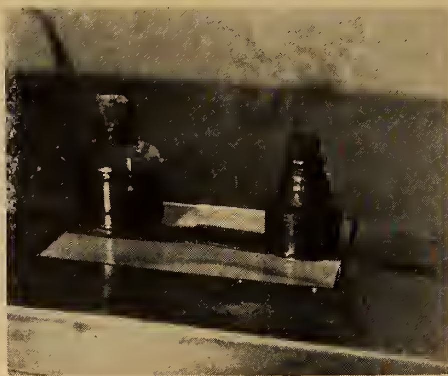


FIGURE 4

had been removed previously, also while the film was under a weight.

Fig. 5 shows one end raised by the scissors, so that cement can be applied to the other part. The scissors is then removed, allowing this end to fall into position over the other piece. The parts will still be aligned because they have not been shifted, and pressure is applied with the fingers or another flat object is placed on the splice. This takes much longer than the modern method, but the projectionist had nothing else to do: he stuck around pretty close, turning the crank.

A one-armed man had nothing much on us. Near the end of the show we got into street clothes and were ready to go when the show was over. (No time to get dressed *after* the break.) Managing a tie and a double-bow knot in the shoe laces with one hand was a daily occurrence. This was more complicated than splicing film, as we could not use weights.

Then there was the knack of making a fast thread-up, the time for which decreased with practice. Turning the trick within twenty seconds was pretty good, for a while. Soon the time required decreased to ten seconds, for a complete thread-up. I say "complete" because

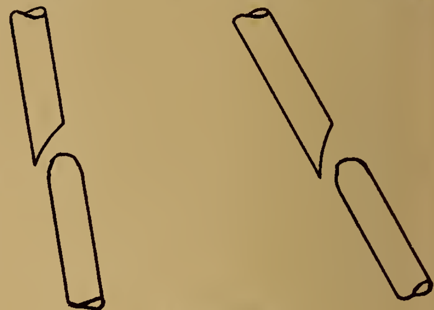


FIGURE 3

this was reduced to seven seconds on an old Edison machine by a little "cheating": the tail-pieces on all reels were cut off at the end of the picture. As the end came off the upper reel, it (the reel) was taken from the spindle and thrown on the bench. Remember that this happened while the machine was running and before the end of the film had passed the aperture.

The projectionist watched the end as it left the upper sprocket, and when it reached the aperture the light was cut and the machine stopped. The other hand was placing the next reel on the upper spindle, the right length of film for threading having been unwound previously and left dangling from the bench. (The rewind bench was always just to the right of the projector). The film was then placed on the upper feed sprocket, on the intermittent sprocket, and the gate was closed and the machine started.

This was all the time needed for threading. After the picture was on the screen the projectionist removed the full take-up reel, replaced it with an empty reel, threaded the lower sprocket and placed the film on the lower reel. The fact that the machine was motor driven at this time made things easier. Projection speed was only 60 feet per minute, and during the latter part of the threading the speed was reduced even

FIGURE 5

below that. Such procedure obviously would be impossible today.

The writer improved the ordinary

(*Continued on page* 34)

New Standards For Old

By *THAD C. BARROWS*

PRESIDENT, PROJECTIONIST LOCAL 182, BOSTON, MASS.

THE motion picture industry, too, is evidently suffering from the ailment of over-production. Having failed by a narrow margin to anesthetize the cash customers with three-hour programs which include two features, a newsreel and a short, the industry intensifies its drive toward the goal of self-extinction by setting up numerous new technical standards so that we may the more quickly forget the old, and by persisting in tolerating needless severe handicaps to the reproduction process.

I was much interested recently in reading a booklet published by the Academy of M. P. Arts & Sciences in which appeared detailed information relative to nine types of sound tracks together with data relative to projecting "Hi-Range" prints and to standard fader setting instructions—all for the avowed purpose of achieving "maximum showmanship". What showmanship?

Some Current Shortcomings

Mention of the Academy implies no desire to attach all the blame for the shortcomings mentioned hereinafter to Hollywood; the exhibition field is equally guilty. The aforementioned booklet is tangible evidence that we have come a long way since 1930. But it might be a good idea if, before passing on to "Hi-Range" prints and other select technical company, we actually observed those standards established eight years ago. Consider first the Standard Release Print, the fruit of the first real cooperative action between production, distribution and exhibition in the history of the industry, with which event we all are familiar.

Start marks are either misplaced or forgotten entirely. Changeover dots are placed on dark scenes, on moving objects and at times are missing. Twentieth Century-Fox apparently is conducting a guessing contest with projectionists by means of switching dots from the top to the center to the lower corner of the film frame. They still manage somehow to keep them on the right-hand side of the frame. The positioning of changeover dots on a dark background is tantamount to their elimination. And then the distributors moan and threaten to bill theatres for mutilated film when harassed projectionists, particularly on one-man jobs, utilize their own markings or punches in order to put a show on the screen.

Mention of film density standards is futile: there are none. Even a 125-ampere, high-intensity arc light can't penetrate some prints supplied to theatres. The manager or owner, mindful of his investment in high-intensity arc equipment and of his carbon and power bills, demands more light; and the projectionist, unable to deliver beyond the limits of his equipment, is blamed for all the errors made in the print on its journey from camera to the projector.

Another serious defect is the so-called "artistic" print, the product of certain "moody" directors (should we say mouldy?) or of some old chromo who fights to keep the truth about her age from the cash customers by insisting upon what is termed a soft focus. We can get almost the same result with an inferior or oily lens, but the manager who pays top prices for good optics that produce a clear, sharp picture has yet to discover this.

Sound level standards are non-existent. Some current prints vary eight points on the fader. The present crop of studio musical directors apparently regard the print as a medium exclusively for the display of their own stuff; no intelligent soundman, unless coerced, would turn out recordings wherein incidental music is as loud as, or actually smothers, the dialogue. Result: theatre managers call for a few points lift on the fader, thinking thus to favor the dialogue over the music.

Over-run sound tracks are quite common. On many recent occasions I have seen sound tracks with a white line cutting into picture and making it impossible to fill the screen to the side masking. Paramount News is very careless in this respect.

Warner Wants Wax

Waxed prints, an old evil once eliminated but resurrected by Warner Brothers despite the almost unanimous disapproval of competent technicians, is again plaguing projection. Some Warner prints are so heavily waxed that it is almost impossible to keep the gate free from accumulated wax, the result of aperture heat. This is a common cause of severe distortion and not infrequently occasions a sound outage, in addition to causing an unsteady picture and possible scratching.

The handling of film by exchanges leaves much to be desired. So badly dented are some cases that it is almost impossible to remove the film without serious damage. Reels are badly bent, and at times the hubs are separated from the sides, the result of being dropped or rolled downstairs in an exchange. Film handlers seem to regard the new large, heavy cases as indestructible, which they most certainly are not. Some of this damage could be avoided by limiting the contents of the cases to three double reels.

It seems to me that before sounding huzzahs for the great technical advances being scored by the industry, as represented by the wave of new "standards," we might with profit to all concerned pause to look backward down the road we have come. This statement implies no criticism of improved technique or of any proposed standard. But it must be obvious to all that unless those rules of the game, so to speak, applying to the fundamentals of the art, both in recording and in reproduction, are observed, the resultant errors will go far to cancel out, if not nullify, any subsequent improvement.

Now—or in the Future?

The shortcomings mentioned in the foregoing brief summary, which by no means covers the entire range of deficiencies, have been the topics of numerous discussions among technicians for many years past; but there the matter rests. The solution of these problems requires no expenditure of money but merely the cooperation of studio, distributor and projectionist and a firm determination to eliminate these individually small but cumulatively big bars to better motion picture reproduction.

Meanwhile all this activity anent new standards reminds me of the harried businessman, who, having just signed a promissory note, puts away his pen saying, "Thank God that's paid." Continued indifference to requests by projectionists for help in improving standards may one day cause the craft to lose interest in good reproduction on the theory that they don't make motion pictures but only show them, and are paid on that basis. When and if that day arrives, it may be too late for Mr. Producer to regenerate such an unselfish interest in the presentation of his product.

L. 244 HONORS P. A. McGUIRE

P. A. McGuire, for more than 20 years advertising manager for International Projector Corp., was elected an honorary member of Local 244, Newark, N. J., and also of the Local's social appendage, the Loyalty Club, at a dinner sponsored by the latter on Feb. 11. Mr. McGuire's acceptance speech reiterated his deep interest in and support of the projection craft, which fact is attested to by his many-sided activities within and without the projection field in behalf of the art and the craft.

Types of condensers for various applications

Notes on Capacity *and* Condensers

By *L. P. WORK*
MEMBER, PROJECTIONIST LOCAL UNION 601

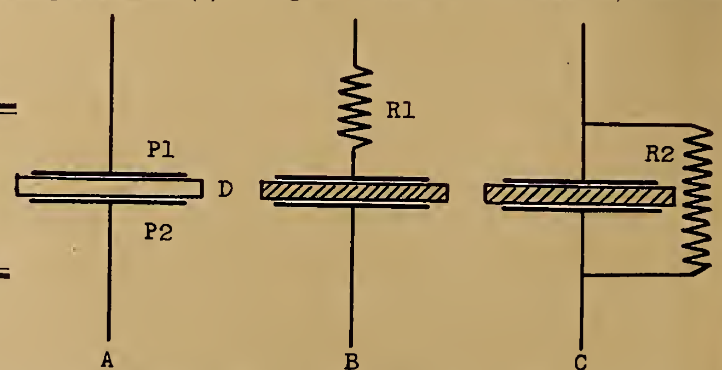
ELECTROSTATICS and the electric condenser play an important part in maintaining sound reproducing equipment at the level of best performance. After the early faults in the equipment are found and corrected, a large part of the usual run of trouble is associated with three types of parts, namely, tubes, resistors and condensers. Tubes may easily be changed and a quick check by substitution had without any special test equipment; resistors are easily checked for continuity and ohmic value with simple meters; but condensers are prone to hiding their faults —in fact, sometimes a condenser fault cannot be disclosed by instruments at all.

In the past twenty years this subject has been somewhat neglected in the regular college engineering course, but in recent years with the wide expansion in the electronic arts more attention is being given. Before continuing with the applied phases of the subject, let us consider the electrostatic theory of the device.

Man's earliest knowledge of electricity was that of frictional charges on amber and other "electric" substances which, the ancients discovered, would attract or repel other light bodies on being rubbed. An experiment in physics commonly used to illustrate electrostatic flux lines about a charged body is shown in Fig. 1, wherein a highly-charged rod A pierces the horizontal glass plane B upon which finely divided cotton lint is sprinkled. The lint will be quickly arranged along the radial lines of the arrows, this action taking place without flow of current in the rod—merely the presence of potential. This charge on the amber is the same as the static potential resting in the dielectric of a condenser.

The condenser is unique among all electric devices with which we deal in that it is the only one which functions as a static storage medium. A theoretically perfect condenser will store a charge indefinitely and at any future time discharge the same quantity as it received. An elementary perfect condenser is shown in Fig. 2A wherein the plates P1 and P2 are separated by the perfect dielectric D. When a voltage is applied to P1 and P2, a flow of current takes place momentarily until the condenser is "full" and equilibrium is reached. This inward flow of current is stored electrostatically, the quantity being proportional to (a) the area of the plates, (b) inversely proportional to the distance between the plates, and (c) directly proportional to the relative permittivity or specific inductive capacity of the dielectric.

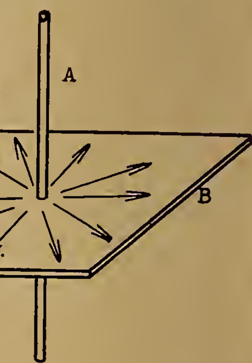
FIGURE 2



The quantity of electricity stored by a condenser is measured in coulombs Q, which is the number of electrons per second a potential of one volt will force through one ohm of resistance. The capacity of a condenser is defined as one farad, if when one volt is applied, a charge of one *coulomb* is stored. The *farad* in relation to the *henry* and the *ohm* is too large for general use, so the *microfarad* (mf, one-millionth part), or the micro-microfarad (mmf, one million-millionth part) are adopted as working units.

If the capacity of this condenser were measured with dielectric D removed, and later measured with it, it would be found in the second instance that the capacity would be increased several-fold even though the area and spacing of the plates were unchanged. This is due to the greater permittivity (designated K) of the dielectric compared with air, which is the standard. With air having a permittivity of 1, some common dielectrics run as follows: glass, 5-8; paper, 1.5-2.5; oils, 2-2.5, and mica, 2-6.

FIGURE 1



A high permittivity is only one of several properties a desirable dielectric should have: it should be of high resistivity to prevent leakage of the charge from one plate to the other; it should be of good dielectric strength to withstand puncturing strains; it should have low intermolecular friction when under alternating electrostatic stress to minimize heating. These desirable qualities do not necessarily go hand in hand in a given material: for instance, electric slate and glycerin have K factors of 30 and 56, respectively, but their leakage would be too high to be usable. The

dielectrics used commercially are those which can best be handled and still afford usable capacities at reasonable costs, such as paper and mica; the electrolytic condenser which uses a chemical film dielectric we will consider separately.

The need of high ohmic resistance can easily be seen in the case of blocking condensers used to couple the plate of an amplifier tube to the grid of the next stage. This condenser passes the a.c. component of the signal, but must not have enough leakage to allow the positive plate potential to alter the much smaller negative potential on the grid of the following tube, otherwise the succeeding stage will distort. And a very small leakage will do this because of the normally high resistance to ground of the grid circuit which makes the IR drop considerable even with minute currents. A situation similar to this obtains in the majority of applications in sound equipment, i.e., a.c. must be by-passed with very small d.c. leakage.

Dielectric Strength

In any insulator the thickness of which is definitely limited as in a condenser, the problem of strength against direct puncture basically influences choice because it is this puncturing strength which sets maximum, hence working, voltage. If we increase thickness, we decrease capacity because of the greater plate separation and thus lose the advantage of a good K factor; also, a slight increase in thickness means a great increase in the size of the finished article.

The exact mechanism by which puncturing proceeds is not clearly understood, due in part to the fact that our knowledge of molecular physics is confined largely to liquids and gases. The dielectric strength is given as the smallest potential necessary to cause a rupture. Heat plays an important part in this factor, as most materials have a positive temperature characteristic, and any rise tends to lower puncturing strength.

Most insulating materials are not absolutely homogeneous and therefore may allow minute leaks to start in an advantageous path through the cellular structure. The power loss in such a small leak may not be noticeable, yet the heat generated is concentrated in the minute path traveled and the fault develops cummulatively until puncture results. A condenser will therefore stand an excessively high voltage for a short period and yet sustain only a much lower voltage for a long period; this fact provides the basis for the standard two-voltage test for rating purposes.

Dielectrics have a hysterisis* characteristic which is similar in some respects to the magnetic hysterisis of iron and produces a loss in the form of heat. The dielectric molecules and the few free electrons present tend to orient themselves under the influence of the plate potentials, therefore the rapid changes imposed by a.c. create an internal temperature rise which in the audio range of 10 kc. or less is small, but in the radio frequencies may reduce the safe working voltage to 1/3 or ¼ of the normal d.c. voltage.

Inherent Condenser Losses

From the arrangement of Fig. 2 it is but a step to the arrangements used commercially, as shown in Fig. 3. When paper is the dielectric the form is of long strips of foil and paper wound in a shape of 3A, while with mica or glass the pile arrangement of 3B is used. These processes are carefully handled and the whole assembly sealed in a container with a non-hygroscopic wax. Small mica condensers are often completely encased in moulded bakelite, which gives a unit impervious to atmospheric conditions and of an extremely low power factor.

A condenser is not a perfect storer of electricity but has various losses which for analysis may be grouped and considered as a series resistor, R1 of Fig. 2B. This resistance, which should not be confused with the capacitative reactance in ohms of the condenser, represents the dielectric hysterisis loss, the loss from ohmic resistance of the plates and other lesser factors. Another loss due to leakage of the applied EMF through the dielectric is represented by the shunt resistance R2 of Fig. 1C.

A theoretically perfect condenser has a current leading the voltage by 90°, but all practical condensers have a lead of something less than 90°, depending upon the magnitude of the losses. This angular difference, expressed in per cent, is called *power factor*, hence is a measure of the relative efficiency or "goodness" of a given condenser, a low per cent being the desired goal. Paper condensers have power factors in the order of 2%, mica .08%, and the electrolytic type 5%. At higher frequencies the losses and the power factor rise sharply on all types, and at ultra-high radio frequencies mica or one of the newer "synthetic" dielectrics must be used. The higher power factor of the electrolytic type is no objection in their use for power supply and many radio and amplifier applications. For example, the 8mf-450 volt unit, of which three might be used in a power pack, would give a shunt leakage of less than 3 milliamperes, which is negligible for this purpose.

The Electrolytic Condenser

An entirely different type of condenser and one which has the widest use in radio is the electrolytic. While the principle is not new (it having been known in the 17th Century that platinum electrodes immersed in a solution of sulphuric acid gave capacities as high as 10 mf per square centimeter at voltages in the order of two) it is only in the last decade that any wide use of it has been made.

Some metals, such as aluminum, magnesium, and tantalum, when acting as the anode or positive plate of a condenser in the presence of a suitable electrolyte, exhibit a polarization due to a film formed on the surface. This film is a polarized non-conductor and is believed to be composed of a layer of the metallic oxides along with occluded gases; because of the extreme thinness in the order of four one-hundred thousandths to four ten-millionths of an inch (this lesser value holding for a low-voltage type formed at 30 volts) tremendous capacities may be had in a small space.

About 1.16 mf per square inch can be had on a plate formed at 30 volts, which is one thousand times greater than a comparable paper condenser will afford.

The basic type consists of a liquid-tight copper or aluminum can used as a tank for the electrolyte in which is immersed the electrodes suspended by an insulating cover or stopper. Various electrolytes are used, the most common being an aqueous solution of ammonium borate or sodium borate (borax) and

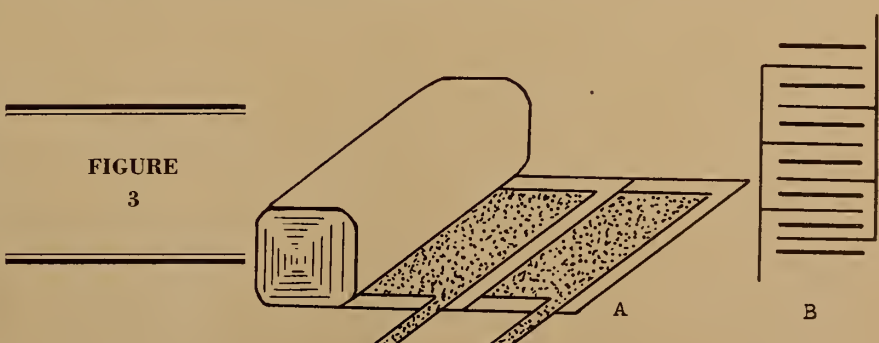


FIGURE 3

*In physics, the lagging or retardation of one or two related forces or phenomena on account of some change taking place in the medium through which they act.

some boric acid, while with tantalum electrodes dilute sulphuric acid is used. Inasmuch as the cathode or negative

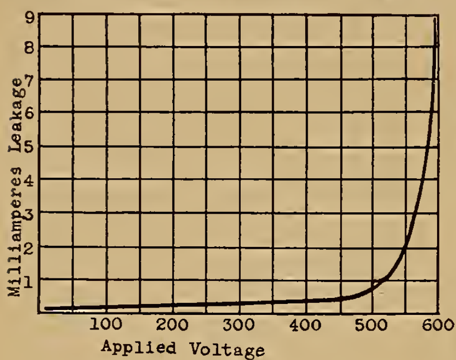


FIGURE 4

electrode acts only as a contact with the electrolyte it may be used as the container, a common form being a can with three anodes, the can acting as the common negative in the filter circuit.

During manufacture the anode must be "formed" by building the initial anodic film across the potential at which the condenser is supposed to operate, the capacity per unit area depending on the film thickness, which is a direct function of the forming voltage. For example, an 8mf unit formed at 450 volts may have as high as 35 to 40mf when formed at 100 volts. This anodic film is a dielectric as long as the anode remains positive; when a negative potential is applied the film breaks down and the condenser is practically short-circuited.

This film also has a definite puncturing strength to a voltage in the normal direction, which, when exceeded, causes a breakdown that is automatically repaired when normal voltage is resumed.

Compared with paper, oil, or mica condensers, there is considerable leakage in the electrolytic type which increases sharply when maximum voltages are reached (as shown in Fig. 4) but normally it is in the order of .2 milliampere or less per microfarad. Thus is provided a safety valve for line voltage surges and to act as a shock absorber in the warming-up period in radios and small amplifiers by deliberately designing heavy shunt leakage at the region of maximum voltage.

The capacity varies directly with the temperature, giving a characteristic which may reduce an 8mf unit at 72° F. to as low as 4mf at 32° F. In the range of ordinary operating temperatures this effect is negligible. The leakage, power factor, and capacity all tend to change with age and other results of use, but these objections are far outbalanced by the great economy in cost and size over all other types.

A further reduction in size is obtained in the so-called dry type in which the electrolyte is carried by a layer of gauze or other absorbent material wound between the foil plates. The anode film forms in the same manner as in the wet type, and the whole unit may be sealed in a wax board container which permits operation in any position.

The principle of increasing the effective anode area by etching the electrode surface and thereby raising capacity with no increase in materials or size has further reduced bulk so they may be used almost anywhere in a chassis for by-pass purposes. The development of the dry electrolytic to the present state of reliability with extreme high capacity and very small bulk is a feat of laboratory research and manufacturing resourcefulness.

Hints on Test Procedure

Previously in this article it was intimated that condensers offered many elusive problems: frequently it may be advisable to go right through an amplifier and replace all the smaller condensers, good or bad. At the present time the technician and projectionist have at their command several devices which go a long way to insure satisfactory tests. Fig. 5 shows two impedance bridges which will measure capacity, leakage, and power factor. The bridge on the left has a range from .00001 to 70 mf; the other runs from .00001 to 100 mf; both use a 6E5 electric-eye tube as a balance indicator. These ranges do not include the low-voltage capacities used in A power and exciting lamp supply units, which may be tested by the voltmeter-ammeter method. This method, however, involves heavy cumbersome equipment which is unsatisfactory for use outside the laboratory. The writer knows of no existing small portable test device for this purpose.

In replacing electrolytics which are continually failing in filter circuits the surge voltage should always be checked to make sure that the condenser maximum is not exceeded during the warming-up period. Smaller a.c.-operated amplifiers which have all heater-type tubes and a filament-type rectifier do not present a sufficient load when first turned on, because the rectifier filament builds up emission faster than the load and thus may present a dangerously high transient voltage.

To observe this, disconnect all filter condensers and place a 1 mf paper condenser at the filter output and a high-resistance voltmeter at the filter input. The maximum swing should not exceed the surge voltage given on the condenser label. It can be shown experimentally that under conditions of no-load the output of a rectifier approaches the peak voltage of the impressed a.c.

A useful device with which to explore an amplifier chassis consists of an 8 mf tubular electrolytic with a probe and flexible lead connected to the condenser case, while the anode connector serves for the other probe. By using this as a temporary substitute capacity an open filter unit or source of hum may be shown; however, it will not reveal high leakage or shorts.

Examples of Application

With the recent increases in power and frequency range of sound picture reproduction brought about by such advances as push-pull recording, high-resolution film, ultra-violet recording, the general reduction of background levels, and, most important, the improvement in horn systems, the demands on an amplifier are more rigorous than ever. The db gain must be larger, the background levels lower and the frequency, amplitude, and phase distortion held to new lower levels.

The introduction of negative feedback has in one stroke reduced these distortion factors to a degree never before possible, but does so at the cost of gain. With this need of increased gain the instability through regeneration and interstage coupling increases tremendously, which can be controlled only by elabo-

FIGURE 5

(*Continued on next page, Col.* 1)

New Simplex E-7 Projector A Great Advance in the Art

SIMPLEX E-7 is the name of the new and, in several respects, radically different projector mechanism just introduced by International Projector Corp. as the first fruit of a widespread developmental program which is expected to be rounded out soon with the production of a Simplex 16 mm. sound projector and a completely new theatre sound system of exclusive International design from soundhead to horns.

The E-7 projector is now on sale at National Theatre Supply Co. branches throughout the country. The Super Simplex mechanism will of course continue to be produced and sold.

On pages 18 and 19 of this issue is a pictorial presentation of the E-7 projector which includes those units considered to be of particular interest to the practical projectionist, thus there is given here only a brief summary of the E-7 highlights. Units of this new mechanism will be described individually and in detail in future issues of I. P., a program which will be assisted materially by suggestions and questions from projectionists.

The Simplex E-7 is designed to meet the most exacting demands of a quality-conscious audience. New picture steadiness, freedom from blurring caused by oil stains, and more light because of revolutionary shutter design, are some of its advantages. It needs less maintenance than any previous model, for the better quality of its screen image is derived not from mere refinements of construction but from inherently better projection arising out of improved basic design. In consequence the E-7 will retain its superiority through a longer period of peak performance than any ever known. Moreover (and perhaps most important of all) new conveniences of operation rid the projectionist of small obligations of routine and leave him freer than he has been to concentrate on screen presentation.

An automatic, one-shot lubricating system assures that every bearing receives a precisely metered quantity of clean, filtered oil. None can be forgotten or overlooked. None takes the eye or mind of the projectionist away from his screen. And there is no surplus of oil to spatter the film compartment and soil the image.

The intermittent movement operates with a wholly new smoothness and freedom from vibration, the result of an oil cushion introduced between star and cam. Far closer tolerances are thus made possible. Every show during the life of the mechanism benefits through increased screen steadiness. Every part of the projector and sound head wears longer through reduction of vibration.

The new governor is of the ring-type of construction, trouble-free, bind-proof, and absolutely silent in operation. The drive gears are oversize, and the transmission gears are helical in design. No amount of wear can make the new synchronizing device produce travel-ghost.

Side sway of the film is controlled by replaceable guides, spaced with microscopic accuracy, which act in conjunction with the guide rollers. Irregular loss of picture steadiness is prevented by an exceptionally long pressure pad combination, which exercises complete control over the film from the intermittent sprocket to a point far above the aperture. Double shutters—front and rear—interact to give more light, a sharper image and far less eye-strain. The automatic, free-falling fire shutter is positive in action and prevents aperture fires under any circumstances whatever.

White, illuminated interior facilitates threading, makes dirt plainly visible and therefore more promptly removed. The special framing lamp minimizes the chance of the picture appearing out-of-frame on the screen, regardless of the darkness of the print.

(*See pages* 18 *and* 19).

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rate by-passing and isolation of the stages from common impedances by adequate filtering.

A representative stage of amplification, illustrating the importance of condensers, is given in Fig. 6, in which a screen grid tube is resistance-coupled to the following stage. The capacity Cc provides a low common impedance for both the grid and plate circuits across the bias resistor, which otherwise is a common impedance of about 2,000 ohms. In earlier practice this would be .5 mf, but with the dry electrolytic type 5 to 20 mf is used, which actually fulfills the requirements that the capacity reactance be less than the resistance which it shunts.

The characteristics of Cb, the coupling capacity to the following grid, are very important as the size of this condenser determines the low-frequency cut-off and therefore the bass response. It must be large enough to provide low response and yet must have extremely low leakage to prevent the positive potential of the preceeding plate circuit from affecting the grid. Other things equal, leakage increases with capacity, and as a result, for condenser Cb a good grade of paper or mica must be used.

The two networks at the lower part of Fig. 6 are filters which reduce the feedback signal (not to be confused with negative feedback for corrective purposes) from the common interstage impedance of the power supply to values lower than the overall gain of the amplifier. To accomplish this the capacities of C1 to C6 must be large enough to have a low impedance as compared with the resistance they shunt, thus offering a virtual short-circuit to ground of the harmful feedback.

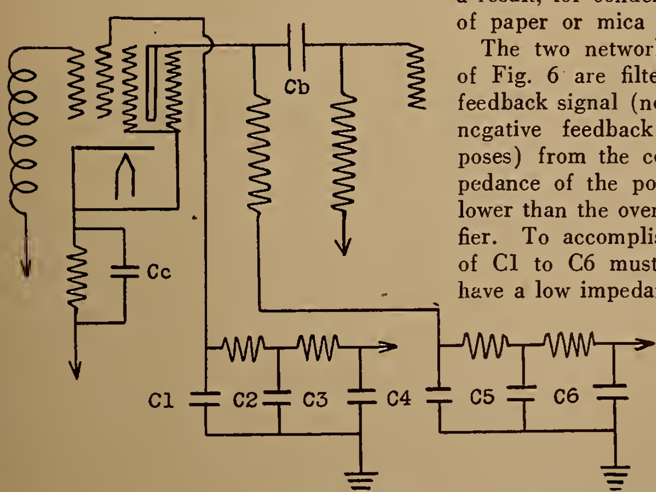


FIGURE 6

THE PROPER USE OF ILLUMINATION TERMS

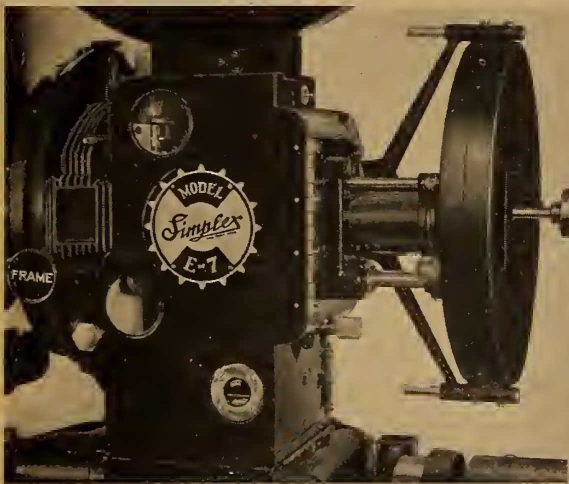
Appended are excerpts from a discussion of illumination terms by Messrs. G. H. Stickney and E. C. Crittenden which appeared in the "Transactions of the Illuminating Engineering Society" (Feb., 1938, Vol. 33, No. 2).

SEVERAL instances of inaccurate usage center around the . . . term "illumination." The Society has defined "illumination" as "the density of luminous flux on a surface . . . " The most common unit of illumination in this country is the "foot-candle." This might be referred to as a *quantitative* meaning. While the Society does not so define it, it is obvious that illuminating engineers, in common with laymen, also use "illumination" in a *qualitative* sense to denote a process or, as the dictionary puts it, the "act of illuminating" or "state of being illuminated."

Some technicians, conscious of the two meanings, doubt . . . that "illumination" connotes the quantitative meaning of the I. E. S. definition, and so they look for a substitute or an explanatory expression . . . It appears that . . . where one of these expedients is resorted to, the sense would be absolutely clear without it. For example, "illumination of 20 foot-candles," "more illumination," "higher il-

(*Continued on page* 33)

The New Simplex E-7 Projector: A

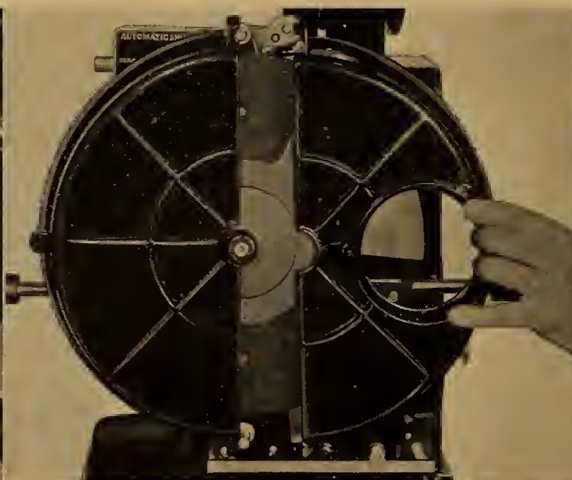


Synchronized Front and Rear Shutters. Advantages are: constructional; increased screen illumination; better picture presentation due to dissolving effect; single heavy shaft for mounting both shutters; avoids slight misalignment caused by rough handling in shipment.

One-Shot Oiling System insures positive lubrication to all bearings as required, eliminating possibility of failure, as on previous models. Oil is filtered, thus insuring a clean supply in sufficient quantity at all times.

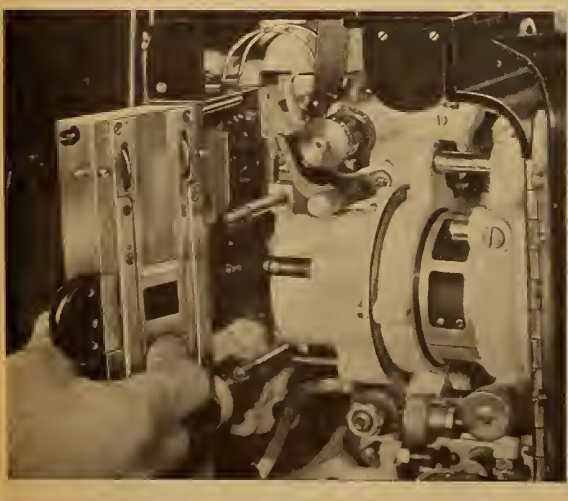
Intermittent Oil System preven oil overflows on drive side. Res Oil cushion under pressure betw closer tolerance and shock abs tion reduction and

Oversize Drive Gears revolving on fixed studs insure longer life and simplify maintenance. This type gear places pressure of operation where it causes least wear. On repair jobs re-bushing of main frame is eliminated.

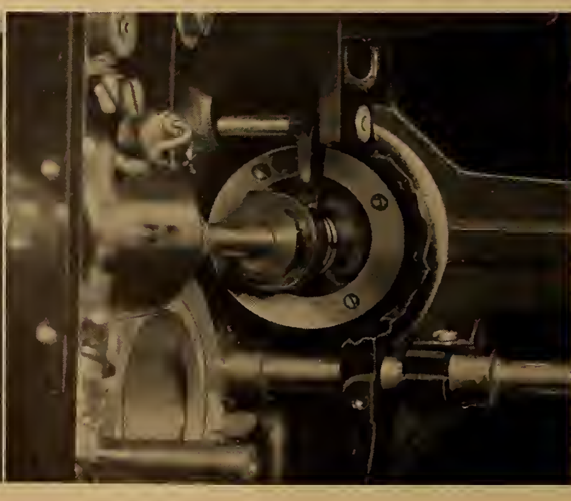


Rear Shutter Guard design permits easy removal of the guard without interfering with setting of the arc lamp and its optical system. Previous models required movement of lamphouse for necessary shutter adjustments.

Framing Lamp, operated by fire positions directly behind aper curate framing regardless of p Box of baffle construction in heat consistently throughout d able without to



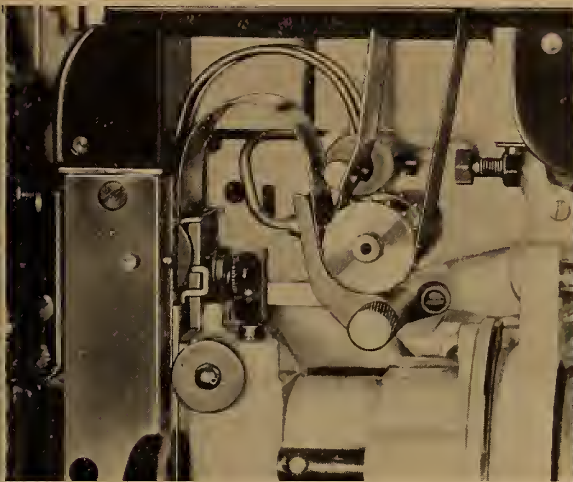
Film Trap is almost instantly removed, assuring easier accessibility for cleaning and adjustment. Contrast this construction with previous models. See close-ups of trap and gate; also, see removal of gate.

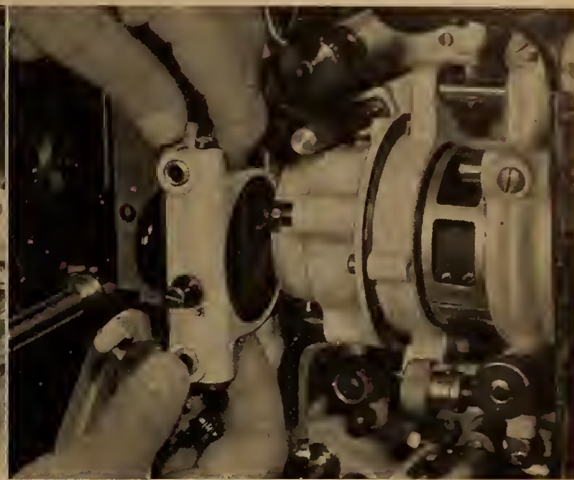


Ring-Type Governor Control for Fire Shutter. This unique type of control, which operates on the principle of a gyroscope, eliminates the possibility of a bind-up and is silent in operation.

Shutter Synchronizing Device a up wear in shutter assemblies, vious models was reflected in impossible in this new E-7 des continuously sharper

Graphic Story of Its Main Features





...ge on operating side. Excess ...n be refilled from either side. ...n ring and star wheel permits ..., insuring longer wear, vibra... ...ased steadiness.

Automatic Fire Shutter Safety Trip provides positive protection against aperture fire by automatically cutting off the light from the film by releasing the fire shutter when film remains stationary before aperture plate.

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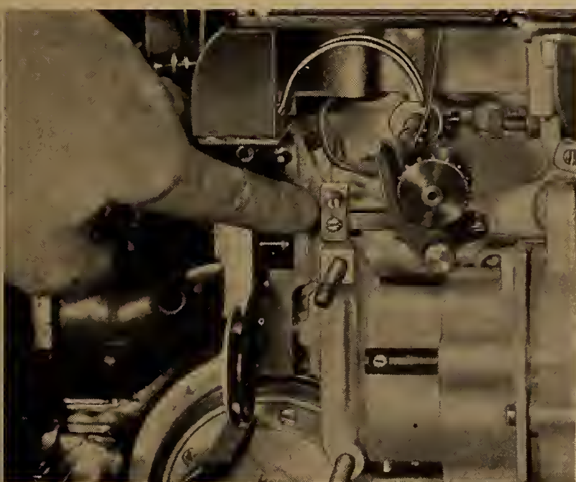

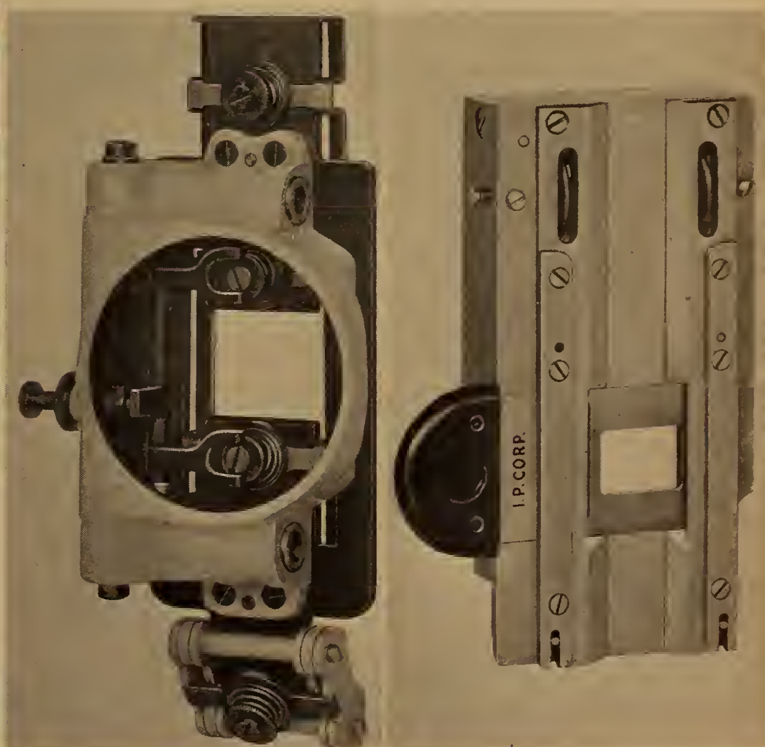

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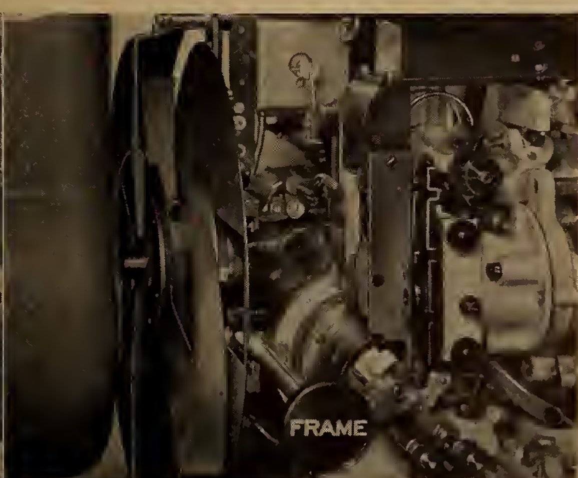
Film Gate Guide. Gate wobble has been eliminated, regardless of length of service, by interaction of four parallel opposing surfaces. The gate is controlled by a flat-sided guide stud, with adjustments for wear.



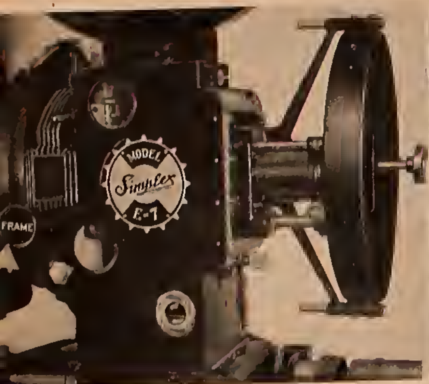
...ically takes ...ear in pre... ...h. This is ...s insuring ...

Rear Shutter Cooling Fins. Newly designed construction of blade and curved vein draw the air backward from aperture and pass it around outside of mechanism, insuring much cooler film path than was possible heretofore.

Improved Film Gate. The increased length of the Pressure Pad combination, together with the Spiral Spring and Adjustable Tension devices, insures that the film will be held in the proper position against the Film Trap with the least amount of tension necessary for the various types of film that may be supplied: namely, oil and shrunk film, unprocessed film and new film. The film is also controlled accurately from the Intermittent Sprocket to a point far above the Aperture, insuring a far steadier projected image.

New Type Film Trap construction. To further insure the utmost steadiness of the projected picture, the Film Trap design includes, in addition to the regular Guide Rollers heretofore used to control side sway, replaceable guides spaced with absolute accuracy. These guides act in conjunction with the guide rollers aforementioned and prevent side sway of the film such as was possible on all earlier models. See close-ups of almost instantaneous removal of both film gate and trap.

The New Simplex E-7 Projector: A Graphic Story of Its Main Features



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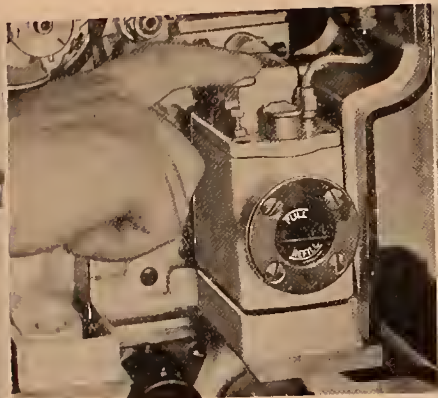

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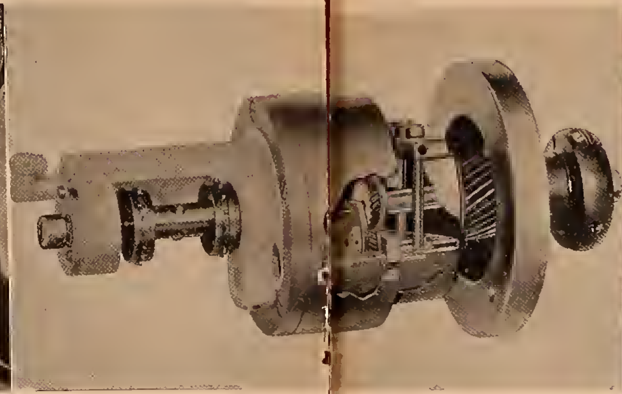
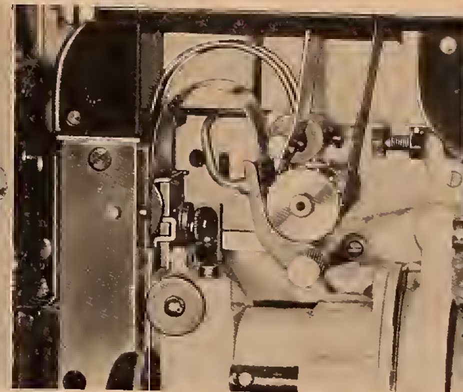


Intermittent Oil System *prevents leakage on operating side. Excess oil overflows on drive side. Reservoir can be refilled from either side. Oil cushion under pressure between cam ring and star wheel permits closer tolerance and shock absorption, insuring longer wear, vibration reduction and increased steadiness.*



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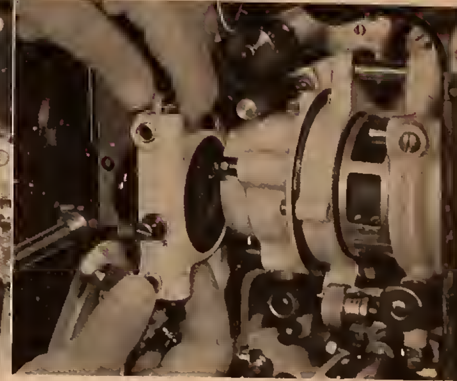

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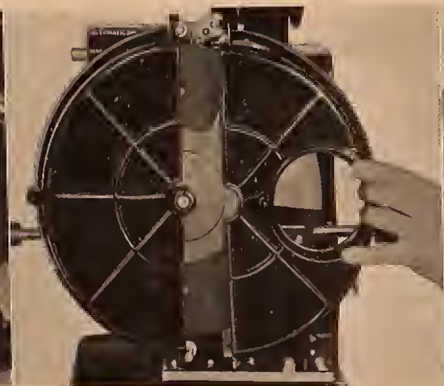

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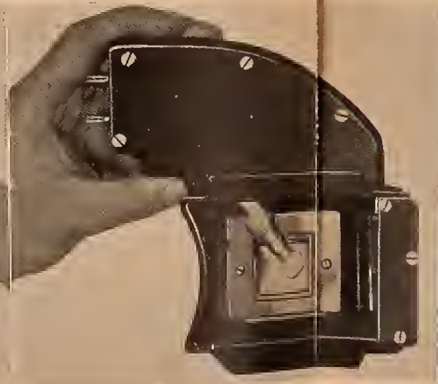
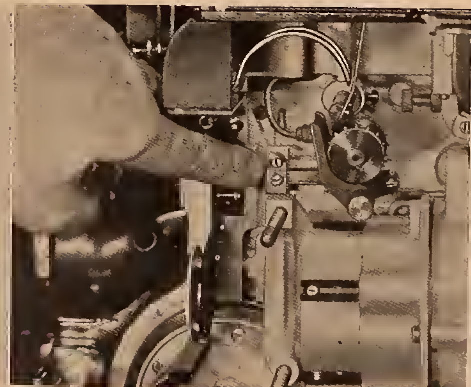


Framing Lamp, *operated by fire shutter lift lever, positions directly behind aperture, insuring accurate framing regardless of print density. Sight Box of baffle construction intercepts, disburses heat consistently throughout day. Easily removable without tools.*



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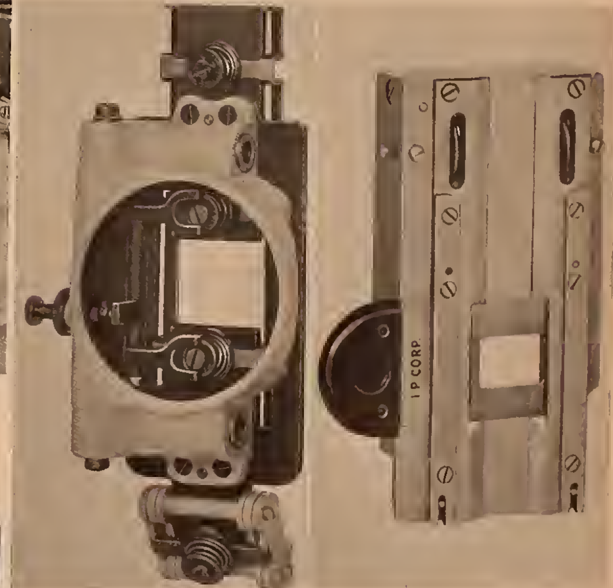

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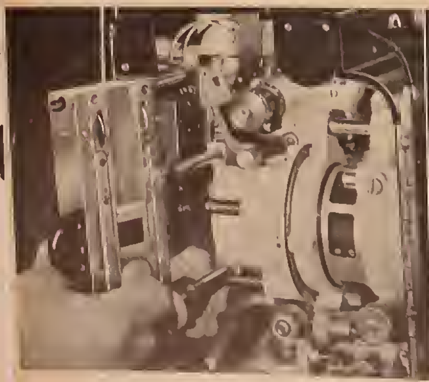
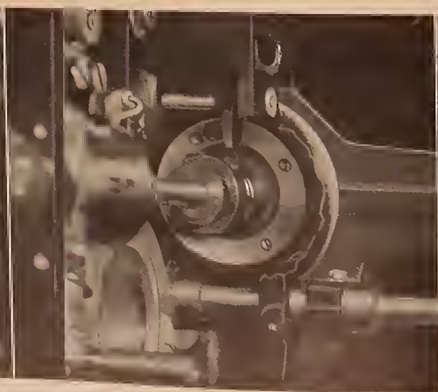
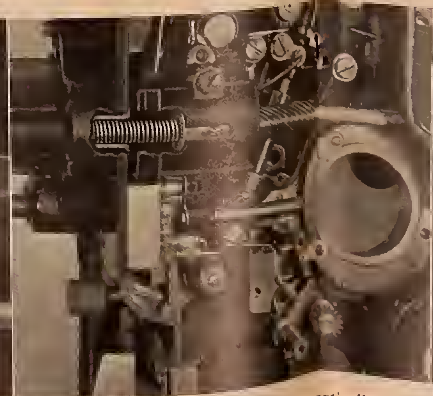


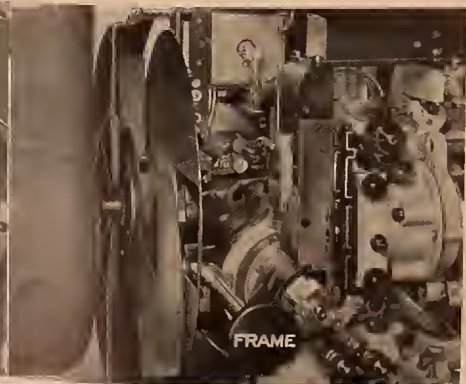
Film Trap *is almost instantly removed, assuring easier accessibility for cleaning and adjustment. Contrast this construction with previous models. See close-ups of trap and gate; also, see removal of gate.*



Ring-Type Governor Control for Fire Shutter. *This unique type of control, which operates on the principle of a gyroscope, eliminates the possibility of a bind-up and is silent in operation.*



Shutter Synchronizing Device *automatically takes up wear in shutter assemblies, which wear in previous models was reflected in backlash. This is impossible in this new E-7 design, thus insuring continuously sharper picture.*



Rear Shutter Cooling Fins. *Newly designed construction of blade and curved vein draw the air backward from aperture and pass it around outside of mechanism, insuring much cooler film path than was possible heretofore.*

The Place of Television Among the Visual Arts

By *DR. A. N. GOLDSMITH*
CONSULTING ENGINEER, NEW YORK CITY

This is the third article of a series covering recent technical developments in television and charting the future of the art. Written by acknowledged authorities on the subject, this series should prove of great value to those interested in the progress of this baby art—as are most projectionists. This article originally appeared in "Television" (Vol. II), published by RCA Institutes Technical Press, and appears here through the courtesy of that organization.

THE new field of television is under rapid technical development and program study. It is reasonable to expect that it will soon be one of the major visual arts, with a technique of its own and with broad applications of great public interest and commercial significance. Accordingly, it seems appropriate to attempt to classify television among the visual arts, to study its relative advantages and disadvantages, and to attempt to judge some of its specified capabilities and limitations.

The other major visual arts are, of course, direct ocular vision, as accomplished by all of us through our eyes, and the arts of still-picture and motion-picture photography. We need not consider here still pictures. It is necessary for our purposes to compare television only with human vision and with motion picture processes.

It seems that television is a curious and rather unexpected blend of direct vision and motion-picture photography. It lies between these two older fields, borrowing from each and perhaps adding its own contribution. It seems worth while to compare these arts more specifically in various basic respects.

Duration of the Image

The first element meriting consideration is *duration* of the envisioned picture. In the case of direct vision the image is completely transient. If we humans were not equipped with memory, our eyes would be of little use, since it is not the eye but the brain that remembers. While it is a convenience to be able to shift our vision from one subject to another, yet it also places us under the handicap of having to retain a vast store of mental images or visual memories.

The motion picture, on the other hand, is a recorded and practically permanent pictorial record. Subject only to the limited factor of physical life of film, a motion picture can be viewed at any time in the future in its original form. The silver image in the emulsion on the film is, in fact, nothing more than the stored memory of previous happenings.

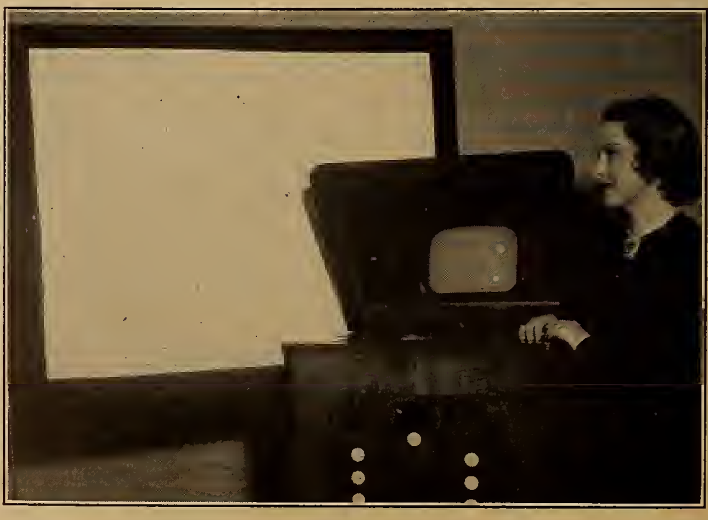
Television, oddly enough, is either transient or permanent, depending on its mode of use and the extent to which it utilizes its allies, the motion picture or, alternatively, the electrical record. If we have a direct television pick-up instantly transmitted to the usual cathode-ray receiver in the home, television is as transient as direct vision. But suppose that at the transmitting station or the receiving station we record the pictures. This can be done either by the usual motion picture process or, theoretically at least, we might record the electrical variations at transmitter or receiver which correspond to the video modulation and the picture controls (such as synchronizing and background currents). In this way we can have either a film record or an electrical record of a television presentation and thus provide a "television memory."

Considering next the element of *color*, direct vision is, of course, color vision (except for the unfortunately color-blind individuals). Motion pictures similarly can be either monochromatic or in full color, though the latter process is not too readily accomplished. Television, in theory at least, can also be either monochromatic or in color. Nevertheless, color television at this time presents a most forbidding aspect to the already sufficiently harassed television experimenter and designer.

Sensitivity of Various Processes

As regards the *sensitivity* of the various processes, direct vision has an extremely high sensitiveness to light and is limited only, so far as we know, by the sensitiveness of the electro-chemical effects occurring at the retina of the eye. Where the sensitivity of the eye is uncomfortably low, we either increase illumination or perhaps use such auxiliary light-gathering devices as the telescope (and ultimately perhaps, the electron telescope with its capabilities of amplifying light). So far as motion pictures are concerned, the process starts with the formation of a latent image, and again is limited by the sensitiveness of an electro-chemical process.

Film may be specially sensitized, illumination may be increased, or some other equivalent measures used if ordinary film sensitivity is found to be inadequate. Television is also limited by an electrical characteristic in its sensitivity, namely, by the sensitivity of the photo-electric effect. It is possible greatly to amplify the output of the original photo-electric pick-up device in television by such means as the secondary-emission amplifier. It is also possible, within limits, to increase the brightness of illumination of some subjects for television. However, consider-



The television receiver, with its reflecting mirror in the lid of the cabinet; and the 3 x 4-foot screen upon which the image is projected

ing the electrical background of each of the three visual methods of pick-up, it is not astonishing that their sensitivities are of the same general order of magnitude.

The *range* of transmission or viewing is quite different in the three cases in question. So far as direct vision is concerned, this extends optically to the nearest opaque obstacle, which may be anything from the walls of a room or the horizon to the furthest regions of the universe. Visual range is readily extended by telescopic devices. So far as the motion picture is concerned, it has, strictly speaking, no range. If a motion picture film and a projector were to be carried to a remote planet, the reproduction would presumably be unchanged.

Television in its most usual form of direct pick-up and reception has a range which extends to the nearest electromagnetically opaque obstacle, except insofar as reflection, refraction or diffraction may extend this range under favorable, but somewhat erratic, conditions. If, however, the television program is photographically or electrically recorded, the range becomes theoretically unlimited. Then again, if individual television stations are connected by radio or wire links, the range of television again becomes theoretically unbounded.

Definition of the Image

Another factor of interest is the ultimate *definition*, the degree of fineness of structure of the image which can be obtained by each of the visual arts. So far as direct vision is concerned, the limitation in general arises from the structure of the retina, which structure is well known not to be continuous. The finite wave length of light imposes a further limit on the definition of images but, in every-day life at least, this is not the limiting factor.

In the case of the motion picture, the grain structure of the developed image is one of the limiting factors. The accuracy of registration of each of the successive projected images on the viewing screen can never be absolute, and this imposes a further degradation of quality or loss of definition on the motion picture image. In addition, the usual optical limitations, resulting from the measurable wave length of light, exist in this case as well. However, motion pictures have been found to be adequately defined under practical working conditions when using modern photographic emulsions of fine grain and suitably limited enlargement.

The television image encounters limitations in definition from several sources. In the pick-up device, the granular structure of the receiving photo-electric screen may limit definition. Alternatively, or in addition, the size of the beam aperture used for the scanning process or for the formation of a "picture element" is another and generally more serious limitation. This limitation exists as well at the receiving end in connection with the fluorescent screen. Not only beam

(Continued on page 31)

Outdoor Theatres Utilize New Projection Set-Up, Technic

By *GEORGE L. McGOVERN*
MEMBER, PROJECTIONIST UNION 223, PROVIDENCE, R. I.

THE growing popularity of the open-air, drive-in theatres wherein patrons sit in their automobiles and watch a regular motion picture program merits the attention of projectionists as to the equipment and technique employed to produce such shows. The first drive-in theatre in Rhode Island is typical of many such plants.

This particular outdoor theatre, built at a cost of $50,000, covers an area of 13 acres and has a capacity of 700 cars —which means, of course, several times that number of patrons. There are ten semi-circular rows in which cars may park, with grades vertically inclined to insure good vision from any location in the enclosure. Traffic is all one way, each row being 50 feet deep to permit cars to come and go at any time without obstructing the view of those watching the show.

Projection Equipment Data

The screen measures 50 x 60 feet and is the largest in the world. The theatre advertises "two shows nightly, rain or shine," the management asserting that rain des not effect screen visibility. (But it does to some extent, of course.) The management stresses the following advantages over a "regular" theatre: no parking problem, informal dress, convenience for the aged and infirm, and free admission for children under 12 years of age.

So powerful are the projectors that patrons in the last parking tier, 600 feet removed from the screen, report no difficulty in seeing or hearing the program. The "projection room" is housed in the pill-box dugout (center background of accompanying photo) half of which is underground. Some projection details are appended:

The throw is 280 feet. Power is supplied by a 50 h.p. motor driving a 280-400 ampere generator, 125 volts. Projection lamps are Hall & Connolly R-10's. National super-high, 160-180 ampere carbons are used. Sound equipment is the latest model RCA High-Fidelity system, with diphonic speaker arrangement. The loudspeakers are positioned above the screen 85 feet from the ground (see illustration). The sound has been heard by people living more than a mile away. Projection handled by members of Local 223, Providence.

[NOTE: Details of the projection room itself should prove very interesting, particularly with respect to projector setup, optical system, controls and various other technical odds and ends peculiar to such an installation. Would you oblige, Mr. McGovern?—*Editor.*]

Panoramic view of typical Drive-In theatre. Note pill-box, or dugout, projection room in center background.

As One Old-Timer to Another

By *EUGENE KLINGENSMITH*

LOCAL 132, WARREN, OHIO

The article "Outline of the Requisites for a Competent Projectionist," by A. C. Schroeder, which appeared in last month's issue, induced many interesting reader comments, two typical examples of which are appended hereto. Bearing directly on the question at issue is the comment by Mr. Klingensmith, who advances some rather novel ideas, to say the least, anent competency. Mr. Schroeder's rejoinder, incidentally, reflects the opinion of I. P.—*Editor*.

I AM an "old-timer," having just completed 25 years as a projectionist, and one of that group at which some of your contributors take a rap now and then. I realize my limited knowledge of the art, thus I have sat tight until now and not commented on various topics discussed in your very valuable I. P. This leaves the field wide open to those Brothers who are blessed with a complete understanding of things mechanical, electrical—in fact, the whole projection art.

I salute our intelligent, and sometimes brilliant, I. A. men who "know all the answers." But I am prompted by Brother A. C. Schroeder's article in your Jan. issue to rise to the defense of we old-timers, who are not supposed to "know all the answers". I'll honestly admit that I fall short of Brother Schroeder's requirements; if I came up to them, I would be worth my weight in gold to any theatre (about 280 lbs., incidentally).

Not all of the misfits, according to Brother Schroeder's standards, are to be found among us old-timers, although I'm not ducking the fact that our ranks undoubtedly have many such. I wonder just how many I. A. men measure up to these standards; and what is to be done about those who don't?

25 Years Ago and Now

These same old-timers of 20 to 25 years ago were faced with a very difficult situation. The outlook was disheartening, with long hours and little pay for just a bunch of crank-twisters who ran a rawhide belt from a fan motor attached to the wall to the projector flywheel—where they could get away with it and the law didn't interfere. The boys were just "operators" then, and none of them could visualize the projection rooms of today.

Now these same men who persevered and pioneered the Union, who made working conditions tolerable and who advanced the craft and its standard of living by fighting for increased wages and *getting them*—now we are referred to as button-pushers. This is a glorious climax to 25 years in the craft and a fine title to tack onto the boys who nursed projection from its infant days of the Edison Kinetoscope and the Powers 5 up to the present. It is almost inconceivable that the old-timers, who have witnessed all the changes and improvements in projection and who are still carrying on, should suddenly be classed as incompetent because they do not measure up to a certain standard that requires them to have a thorough knowledge of optics, sound systems, electricity, mechanics, etc.

Regardless of how much or how little these men know, the fact remains that there still is some measure of protection for them—and just so, because this protection is due to their foresight and perserverance in maintaining their respective Local Unions. And that, if you please, is the background of the success of all organized projectionists, book learned or otherwise.

Doubts That Ability Pays

Through my experience as a projectionist, and considering those with whom I have come in contact, I am firmly convinced that a projectionist of today who really would measure up to Brother Schroeder's specifications could not sell himself for 10 cents more on the week without the support of his Local Union. I have found that various managers and owners are much more interested in how much money they pay in wages weekly, and in how many projectionists they must employ, rather than in how much their projectionists know beyond the ability to keep a steady picture on the screen.

While this condition is no good reason for a projectionist to pass up the opportunity to learn more about his craft (which is available at small cost), it must be admitted that it is discouraging for the old-timer who realizes that his lack of elementary schooling bars him from gaining all the information which today could be his if only he were prepared.

By *S. Robbin, Chicago.*

I disapprove of Mr. A. C. Schroeder's article in I. P. last month. It certainly was in bad taste. Many a manager will use it to slam the projectionist when the opportunity offers. This article could have been written in a nice suggestive manner instead of being scornful and sarcastic: witness the comment relative to a projectionist's need of mathematics: ". . . doesn't he have to figure his pay check?"

Mr. Schroeder could have asked how it would look if a projectionist had to stop his show and wait for the service man to replace a blown fuse; instead he stated it as a fact, which procedure hardly served as well. I agree fully that the projectionist should follow up and study his craft, instead of depending upon other and less worthy influences, but such articles will hardly help to promote that idea. On the contrary, it will complicate matters.

I'm sorry you let this article appear in I. P.

Mr. Schroeder Waxes Explicit

Brother Klingensmith's letter is frank and interesting. It "rings true" and I believe he expressed himself just as he feels. He is mistaken, at least in reference to my writings, in saying that we take a rap at the old-timers. I did not mean to take a rap at anyone, but only wanted to jar some of the boys into trying to better themselves. This includes the newer men, as he intimates in his letter. If I have offended anyone I want to apologize and assure him of no such intent.

Why should I rap the old-timers? I am one myself. and have been in the business

(*Continued on page 30*)

Left-Hand Projector?

To the Editor of I. P.

Attached is a page from *Photo Reporter*, a magazine published by the *Life* and March of Time people, on which appears a picture of (believe it or not) a left-hand Super-Simplex projector. I have never heard of such a projector and I believe that this picture is a printing error, but it prompts the question: Is there such a thing as a left-hand projector?

R. M. HINSHAW
Star & Mayfair Theatres, Weiser, Idaho

No, Mr. Hinshaw, there is no left-hand Simplex projector. The halftone shown in *Photo Reporter*, and reproduced here,

'Photo Reporter's' left-hand projector

is the result of a reversed negative. Whoever handled production on this job evidently felt that the reversed position of the words Super Simplex indicated an error, so he "corrected" it. As a matter of fact these words should read in reverse with the mechanism door open.

Analyses of Modern Theatre Sound Reproducing Units

By *AARON NADELL*

III. Speaker Circuits

SOME part of every theatre's speaker circuits will be found in the projection room, and to that extent those circuits are as much the responsibility of the projectionist as are the amplifiers or any other sound components. The same applies to the entire speaker equipment in theatres that have no stage crew; in others the stage personnel may claim jurisdiction over such apparatus. The monitor speaker, of course, and all its wiring are wholly within the province of the projectionist. The latter also may be asked to check troubles in the screen speakers, and sometimes even in the theatre's acoustics.

Except for some types of monitor units, practically all theatre speakers are wired to two distinct and separate circuits. The speech or voice circuit carries a.c. or pulsating d.c. having the frequency of the sound to be reproduced. The field circuit always carries filtered d.c., the function of which is to excite a magnetic winding in the speaker unit and thus provide a magnetic field.

The magnetic field is vital to the functioning of all standard types of theatre speakers. In some monitors (and very recently, in a very few screen speakers) the field is provided by a permanent magnet. In most theatre speakers the greater part of the bulk and weight of the unit consists of the magnetic winding and its core. A comparatively small and light "voice coil" carries the fluctuating or alternating current of the second, or speech circuit. While it carries that current, the voice coil is a magnet, because every wire carrying current is a magnet.

There are thus two magnets in the speaker which attract or repel each other according to the alteration or fluctuation of the speech current. But only the voice coil is so mounted as to be free to move. That coil consequently vibrates in accordance with the frequency and strength of the current passing through it. It is mounted on a diaphragm—a thin plate of paper, metal or bakelite —which of necessity shares its vibrations and in turn imparts them to the surrounding air. Alternate waves of compressed or rarified air thus are driven to the ears of the audience, perhaps directly and perhaps after rebounding from the walls or ceiling of the auditorium.

Acoustics (fortunately) is not one of the projectionist's headaches, but it is of some interest, particularly when his sound system is blamed for distortion that is really acoustical in origin. The essential facts are quickly reviewed. These waves are propagated through air at speeds which vary somewhat with temperature and moisture, but average roughly 1,100 per second. The figure 1,000 is easier to handle and quite suitable for all practical purposes of the projectionist.

While they cannot be seen, these waves are very easily measured. Consider a frequency of 1,000 cycles: if each wave travels 1,000 feet per second, the first one will be 1,000 feet away (in open air) at the end of the first second, and will have 999 others following it. The waves will be 1 foot apart; each wave is 1 foot long. If there are only 100 of them per second (100-cycle frequency) there will be only 99 following the first one at the end of a second's time, and each wave will be 10 feet long. At 50 cycles per second, which is close to the lower limit of recorded sound, the wave-length becomes 20 feet. At the upper limit, about 9,000 cycles, there are 8,999 waves following after the first one at the end of a second's time, and the wave-length is 1¼ inches.

Sound waves rebound from the hard walls of a theatre and thus cause sound distortion, but their reflection from any given surface may vary with frequency. Thus, if the surface is broken up into recesses, a very small wave (high frequency) may penetrate the recess and rebound from the wall or ceiling as if there were no ornament at all; but a larger wave will be broken up and its energy scattered in different directions. Recesses several feet square and deep are purposely built into walls and ceilings for the purpose of breaking up and scattering the larger sound waves (which give the most trouble by reflection), thus preventing echo and minimizing that lingering of sound, which is called reverberation.

Speaker Field Circuits

The source of the d.c. used to excite speaker fields is, in most modern systems, a rectifier, properly filtered. If the filter is inadequate or defective, hum may be heard, since the magnetic attraction for the voice coil will vary in strength at the ripple frequency, and the voice coil will vibrate accordingly. In some sound systems, particularly small ones, the filter within the amplifier power circuits will include the speaker field coil, or coils, as series inductance. In some theatres, the arc lamp supply is used for speaker excitation, a shunt line running back stage through a filter, and perhaps through a suitable dropping resistor.

So-called "brute force" filters used to

Erratum

An error appeared in the statement beginning with the sixth line under the subhead "Inherent Tube Fluctuations" in the first column of page 19 of I. P. for January. Fortunately, the error had no effect upon the contest questions or answers. The statement should have read:

"If the plate voltage drops a little, the grid voltage must drop correspondingly. But the drop in grid voltage results in a further increase in plate current, and, therefore a still further drop in plate voltage. Under some circumstances, including high volume for the tube in question, this process may continue along the 'characteristic curve' of tube performance until it can go no further, when the next signal or other fluctuation in grid voltage reverses it, and plate current declines while grid and plate voltage goes up. When the other end of the tube's performance limits are reached, the process reverses itself again. In other words . . ."

The original statement that a decline in plate voltage is accomplished by an *increase* in grid voltage, is also true in some circumstances, but in a different connection. In self-bias circuits the plate current returns from cathode through a dropping resistor which provides the grid bias. In those circuits an increase in plate current, by Ohm's Law, raises the grid bias.

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remove ripple from d.c. are shown in Fig. 1. The action is as follows: peaks of current will arouse increased counter-e.m.f. in the inductance and will tend to

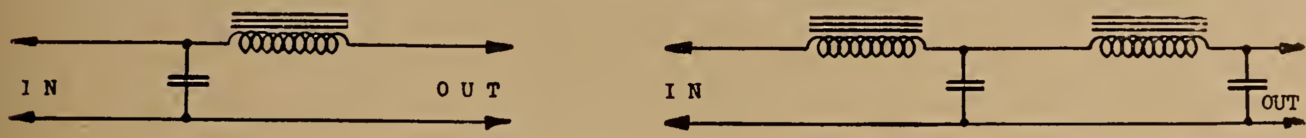

FIGURE 1

be stored in the capacitance; while at low-current values the counter-e.m.f. of the coils will decline and the condensers will give up some of their charge. Consequently the output from the filter will be relatively steady d.c. If the original ripple is not very great, the speaker field itself may be used as one of the inductances, or as the only inductance, filtering itself with the help of a condenser.

Figure 1 shows only two of the several varieties of brute force filters in common use. All of them resemble the circuits of Fig. 1 sufficiently to be recognized at a glance when encountered in any sound power circuit.

Rectifiers supplying these filters and, through them, the speaker fields are commonly of the full-wave type. The rectification may be accomplished by tubes, or by copper-oxide, copper-sulphide or magnesium-sulphide "stacks." The line carrying the rectified current to the screen may share a grounded return with the voice circuit.

Speaker Voice Circuits

Filters of a different kind, but similar in the appearance of their circuits, are used in modern sound systems to split output into both low and high frequencies for transmission to different groups of speakers, or to different power amplifiers which serve both low and high frequencies separately, and are each connected to their own groups of speakers.

Figure 2 is the circuit of a filter which supplies different groups of speakers from the same amplifier. Neglecting the resistors, it constitutes three parallel circuits. The first, entering at top left, runs down through the coil, down through the condenser, and back at bottom left to the other side of the sound source. Current that follows this route never reaches any speaker, and represents an unavoidable loss.

A second path can be traced straight left through the condenser, through the horizontal resistor and out to speakers at top right; back into Fig. 2 at center right, left, down through a condenser and back to the sound source at bottom right. There are two condensers in series with this line, and an inductive winding in parallel to it. The high frequencies will find considerable difficulty in traversing the inductive winding, while the condensers will present only a low impedance so far as such frequencies are concerned. The speakers connected across the two upper terminals at the right are, therefore, the high-frequency units.

A third path runs down through the inductance, right, out to the speakers, back at bottom right and left to the lower input terminal. There is an inductance in series with this path which offers comparatively low impedance to high frequencies, and condensers in parallel to it. Since the current input to Fig. 2 will divide inversely as the impedance, the preponderance of the lower frequencies will follow this last route.

The two rheostats constitute an L-pad which can be used to control the input to the high-frequency speakers, and therefore to modify the ratio of low- to high-frequency sound, according to the requirements of the auditorium's acoustics.

Fig. 3 is somewhat similar circuit used to divide the output of a voltage amplifier between low- and high-frequency power amplifiers. In this case there are (neglecting the resistors) four parallel circuits.

Beginning at upper left, there is a circuit right through a condenser, down through an inductance, and back left and out to source. Another, beginning at upper left, may be traced down and right through an inductance, up through a condenser, and back left to source. These two circuits waste any power that flows through them. The values chosen for the inductances and condensers keep that waste to the minimum consistent with the other requirements of the filter.

Another circuit, beginning at upper left, can be traced left through the horizontal rheostat, out at upper right and through the speakers, back in at common and so left back to source. There is a condenser in series with this line, which therefore favors the higher frequencies, and also an inductance in parallel to it. The latter tends to short-circuit around the speakers any of the lower frequencies that pass through the relatively high impedance offered by the condenser.

Again beginning at upper left, a fourth circuit can be traced down and to the right through an inductance, out to speakers at lower right and back through common as before. This path not only offers comparatively little impedance to the lower frequencies, but also is paralleled by a condenser which tends to by-pass highs around its output load; the exact reverse of the high-frequency circuit of this filter system. The resistors serve the same purpose as in Fig. 2.

Speaker System Troubles

All speakers, having at least one and usually two electrical circuits, are subject to burning out. The voice coil, being the lighter winding (since it must move with the diaphragm) is more subject to failure than the field winding and should be inspected first in case of a speaker that has stopped working.

More common than burn-out is rattle, which may be due to several causes. The diaphragm may have loosened in its mounting. The voice coil is usually arranged to ride in a very narrow slot in the iron of the field magnet so that it may be subjected to the maximum magnetic force. A very slightly shifting of the voice coil will cause it to rub, causing the speaker to rattle. Re-centering the voice coil is comparatively easy

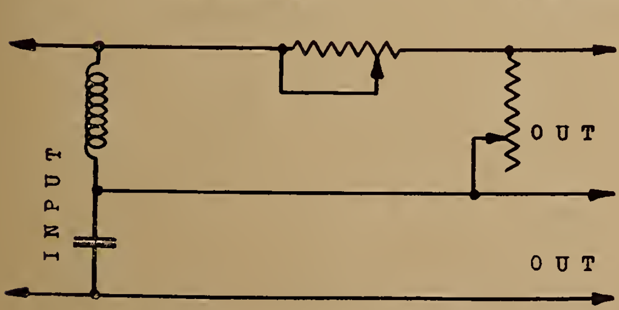

Fig. 2. Tuned filter supplying l.- and h.-f. speakers

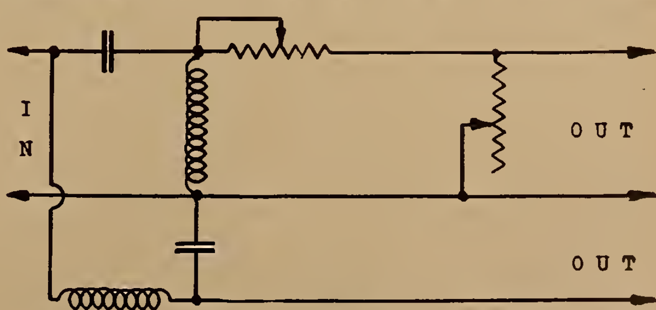

Fig. 3. Tuned filter supplying l.- and h.-f. amplifiers

CONTEST WINNERS

(December Issue Questions)

First Award

EVERETT M. RENFROE

4633 So. Wabash Ave., Chicago, Ill.

Second Award

DON HOWARD

Strand Theatre, Rawlins, Wyoming

Third Award

CARL ROSSI

442 Sterling Place, Brooklyn, N. Y.

Fourth Award

The following all tied for the fourth highest mark and each will receive an identical award:

JACK LEATHERMAN

Local 511, Jacksonville, Florida

T. P. HOVER

Sec., Local 349, Lima, Ohio

K. P. KENWORTHY

Kenworthy Theatre, Moscow, Idaho

BASIL T. WEDMORE

65 Charterhouse Road, Orpington, Kent, England

in some units, and in others impossible without factory facilities. The diaphragm, again, may have been torn or dented through accident or, in some units, through use. The diaphragms for many units can be bought separately, and are easily installed. Others, and particularly those in which the centering of the voice coil is difficult, require factory repairs. Low-frequency units are almost always easier to repair in the theatre than are the high-frequency type.

Rattling may be heard if the unit as a whole has become loose on its horn or baffle.

Phasing presents an important problem whenever a speaker unit is replaced. In general, all diaphragms should move inward and outward in phase with each other. If one moves in while another is moving out—that is, if two are 180° out of phase with each other—one produces a wave of compression just when the other is producing a wave of rarefaction of the air; the two effects tend to cancel each other and volume is greatly reduced. However, there are modern speaker systems in which the low- and high-frequency groups are intentionally wired out of phase.

In any system, the proper phasing is determined at the time of installation, and the projectionist's only concern with it is to see that it remains as originally planned. When a new speaker unit is installed, it is necessary to consider the "polarity" of the voice coil wires, even though they carry a.c. If those wires be reversed, the diaphragm motion will be out of phase. The same result will follow if the field coil leads are reversed. If both sets of leads be reversed, the speaker will be back in proper phase again.

In monitor speakers, and in theatres that have only a single speaker unit behind the screen, phasing does not matter: volume and quality will be identical as long as there is no other speaker to produce acoustical interference. Where speakers are "struck" to make room for stage shows, and their connecting cables carry plugs and jacks, only polarized plugs are used, and no other kind should ever be substituted when replacements are made.

Speaker field supply units are subject only to the normal troubles of any rectifier-and-filter circuits, such as burning out or aging of the tubes, aging of some types of rectifier stacks, burning out, short-circuiting or open-circuiting of condensers or coils; loosening of the laminations of the power transformer (which may produce hum), and shorting, opening or grounding of the internal wiring. Almost all modern filters use electrolytic condensers. These have some tendency to deteriorate with age: when they are replaced, polarity must be considered, since connection in reverse polarity will immediately produce an internal short-circuit.

Speech line filters of the kind shown in Figs. 2 and 3 are likewise subject only to normal electrical troubles of short-circuiting, open-circuiting or grounding of parts or their wiring. A difficulty of this kind will manifest itself as a change in volume, in sound quality or both, usually both. The nature of the change will help to indicate the location of the fault. Thus, a short-circuit of the lower condensers of Figs. 2 and 3 would silence the low-frequency speakers. Short-circuit of the upper condensers in those diagrams would increase the volume from the high-frequency units, probably to the point of making them distort. These units may not, however, come under the direct responsibility of the projectionist, since in some theatres they are located back stage and cared for by the stage crew; in some systems the same is also true of the speaker field supply rectifiers.

The connecting lines carrying speech and field power are sometimes subject to an unusual form of trouble, in that these lines may run through backstage cables, which may be stepped on. In theatres so wired, that cause should always be investigated promptly in case of sudden speaker outage.

Speaker supply lines, either field alone

Description of Awards to Contest Winners

Here is what those who rated the highest marks on the December issue questions will get:

First Award (Renfroe): A Precision d.c. volt-ohm-milliameter having five d.c. voltage ranges at 1000 ohms per volt; four d.c. current ranges, and two resistance ranges. Large 3" square meter, D'Arsonval movement of 2% accuracy; adjust ohms compensator; self-contained battery.

Second Award (Howard): A pair of the latest model Trimm lightweight headphones of exceptional quality and suitable for all standard sound testing.

Third Award (Rossi): A volt-ohm meter, 3-30-300 volts d.c.; zero to 10,000 ohms.

Fourth Award (Leatherman, Hover, Kenworthy, and Wedmore): All four will each receive a Test-O-Lite, considered the handiest electrical tester on the market.

Here are the likenesses of the first group of Contest winners, excepting our British friend, Mr. Wedmore: 1, Everett Renfroe; 2, Jack Leatherman; 3, Don Howard; 4, T. P. Hover; 5, K. P. Kenworthy; 6, Carl Rossi

Here are the Contest Questions—

9. If one tube in a full-wave pair supplying speaker field windings has aged to the point where its partner is doing practically all the work, what may be the result to the sound?

10. How can sound wave-length be found when the frequency is known? Could a test sound of 400 cycles be reflected as echo from a ceiling broken up into recesses four feet square?

11. Raspy sound heard in the theatre is not heard with headphones connected across the speaker line in the projection room? What may be suspected?

12. What trouble in Fig. 3 could cause drastic loss of high-frequency volume? Of low-frequency volume? Of both?

or both field and voice, are commonly fused backstage, and outage of those fuses is another possibility to investigate promptly in case of speaker trouble.

Acoustic Troubles

Monitor speakers, when of the screen type, are subject to the same troubles and treatment. The permanent magnet monitor, however (or permanent magnet screen speaker) having no field winding, cannot cause hum or low volume through any cause except in the sound current supplied to its voice coil. It can rattle through the same causes as any other speaker. Its magnet (if it be of modern type) will not lose strength with time. Some modern systems are equipped with separate monitor amplifiers. In this case the monitor and its amplifier constitute virtually an independent sound system, like any other, except that it

One of these meters is on its way to Everett Renfroe, winner of the first award

derives its input not from a photocell but from the output of a voltage amplifier of the main system; and it is subject to all the normal troubles found in the amplifier and speaker of any sound system.

Some forms of acoustic difficulty may be mistaken for faults in the sound system proper, and cause a great deal of useless work unless they are recognized for what they are. A rattle, for example, may be set up acoustically in a lighting fixture, glass panel at the rear of the orchestra, or other furnishing. In the case of the glass panel the facts are obvious enough, because the rattle is loudest at the rear of the house; but in the case of a lighting fixture located high up under the ceiling, the sound system may be suspect.

There have been cases where loss of volume was blamed on the sound system, when the real cause was installation of new and more heavily padded seats; and other cases in which painting the auditorium changed the frequency-selective absorption of the walls, creating a change in sound quality that caused much useless work in the projection room. The resemblance between echo and an over-loud monitor has been noticed by almost everyone.

One obvious way of checking upon whether or not a given trouble is acoustical is to listen to the speakers at the screen itself. This method, however, fails to some extent in the case of systems that use separate low- and high-frequency speakers, since it is not easy to hear both sets unless one is far enough away to detect acoustical complications also. Some attention to the more elementary acoustical considerations is desirable.

First Prize Awarded for These Answers

By *EVERETT RENFROE*

1. How are sprocket hole noise and dividing line noise distinguished by listening to them? Which sound has the higher pitch?

Sprocket hole noise and dividing line noise, when audible, are easily distinguished. Both are more percussive than musical. However, with 24 frames per second, 96 sprocket holes pass the light, thus giving a modulated light audible at 192 c.p.s. Similarly, the dividing lines cause a modulated frequency of 48 c.p.s.

Superimposed on the dividing line sound are sounds caused by modulated light varied by the various degrees of shading of picture portions exposed between dividing lines. These latter modulations will appear at the same, or harmonic, frequency (multiples of 48 cycles), thus giving timbre to the tone. Sprocket hole noise has the higher pitch.

With an amplifier attenuated at about 240 cycles, or slightly lower, so that 60-cycle current can be used for the exciter lamp, it is possible that neither of the aforementioned noises would be readily noticed, because of their inherently low volume on reproduction — except during quiet intervals or during passage of single sound sources. Both types of noise, no matter how slight, will occasion much tonal distortion.

2. If a trouble lamp is used to inspect the sound head during operation, and the light is allowed to reach the photocell, will there be any effect upon the sound?

A trouble lamp lighted from commercial sources, the rays of which reach the p. e. cell, will superimpose upon the recorded sound a musical tone of modulated frequency of twice the frequency, if the supply current is a.c.; or twice the commutator ripple frequency, if d. c. The volume level of the sound will vary with the square of the distance the light source is removed from the p. e. cell.

A battery lamp can be used, if moved about slowly so that no shadow passes over the cell at an audible rate. This lamp, if stationary and not brilliant enough to cause saturation and ionization of the p. e. cell (with resultant limitation of range of activity affecting loud passages) is O. K., because a steady light induces no sound. It is modulated light that is amplified and made audible.

[Editor's Note: *Photo cell hiss results when the cell is illuminated by any lamp, regardless of the current source.*]

3. If an exciting lamp is kept in use after its filament has sagged, will the effect be the same with both variable density and variable area tracks?

Yes and no, depending upon focusing method and type of recording. Under the given classifications are various types of prints, listed for reference as follows: (1) single variable density (2) single variable density squeeze (3) single variable density double squeeze (4) unilateral variable area (5) bilateral variable area (6) duplex variable area (7) push-pull variable density (8) push-pull variable density squeeze, and (9) push-pull variable area.

The effect would be the same with both types of sound track, that is, loss of light would result in a reduction of both volume and fidelity. The light would not be positioned accurately, although some light would fall upon the area. With one-half the light lost the output would drop 6 db.; with three-quarters of the light lost the output would be down 12 db. Hi-Range prints would show a comparatively greater fidelity loss than Lo-Range and Regular prints.

Light loss is proportionate to the sag in the filament. If the sag is so great that no light falls on the slit, there is no sound with any type of recording; but this contingency is unlikely, because near either support some portion of the filament would pass light to the slit.

With what might be termed a "normal" sag of the filament, Nos. 1, 2 and 3 recordings aforementioned would be reproduced with volume loss and some fidelity loss. The volume loss could be regained through higher fader setting, within amplifier capa-

NOTICE: Participation in the Question & Answer Contest is restricted to those engaged in practical projection work who are subscribers to I. P.

city; the loss in brilliance would be detected only by trained ears. On No. 4 recording great distortion would occur, because the total variation would not pass through the light. Any portion of the recording not getting sufficient light width would suffer volume loss.

With Nos. 5 and 6 type recordings there would be fair quality at lower volume, if the slit were exactly one-half lighted. If under one-half length lighted, the same results applicable to No. 4 would be obtained. If more than one-half length were lighted, somewhat better quality would result, but there would be great volume variations resulting in syllabic distortion.

On Nos. 7 and 9, with the slit one-half lighted, the volume would drop 3 db., reproduction quality being fair except for the loss of fullness on low tones. This effect applies also to No. 8 type of recording, except that the absence of low tones would be more readily detected through the loss of fullness.

4. If sound from one projector is noisy because of vibration (*i.e.*, quiet when checked with projector motionless), how can the cause be found and eliminated?

Use headphones if available, or set fader and monitor to high level and tap all associated sound parts with a light, padded hammer. Tighten or replace loose, worn or otherwise faulty parts, as evidenced by sound produced by the impact. Pre-amplifiers mounted on the projector head hang on springs. A weak spring, allowing the amplifier to rest on the guide frame, must be shortened or replaced, because tubes are microphonic and will amplify any vibration of their elements. If this reveals no faulty parts and visual inspection shows no lead wires to be oil-soaked (if found, replace) the fault must be due to heavy machine impacts communicated to either or both exciter lamp or p. e. cell elements.

Run the projector and check shock-damping mechanism; check smoothness of gear operations; check for sprung shafts and smoothness of intermittent operation. A well-oiled machine will vibrate less than one tending to stick or bind as a result of lack of oil. Particularly don't overlook sprockets, guides, shoes, *etc.*, carrying the film past the light slit; flutter may be of a frequency not so readily recognized as variation in film speed, but still appearing as noise.

[Editor's Note: *Answer fails to state that faster trouble-shooting is possible by blocking off exciting light, which procedure immediately points to trouble as either optical or electrical apparatus. Some other contestants submitted more detailed answers on this one.*]

Those who submitted papers averaging fifty per cent correct or better, but not listed here as they ranked, are:

Roy J. Arnston, Minneapolis; Lester W. Shaffer, Shrewsbury, Pa.; Andrew Burtnett, Hannibal, Mo.; Herman Bridgers, Waxachie, Tex.; Philip Martin, Jr., Washington; Walter Fink, Mahanoy City, Pa.

Also, Lawrence Borgeson, Los Angeles; J. R. Patent, N. Y.; J. T. Kirkham, Calgary, Can.; Leo Cimikoski, Norwich, Conn.; Raymond Bartzen, Sheboygan, Wis.; Roy B. Beal, Ft. Wayne, Ind.; Haynes Howell, Roswell, N. Mex.; Samuel Payne, Burlington, N. C.; E. L. Saunders, Newport News, Va.; Wendell Flauding, Portland, Ind.; J. A. Zochritz, Cushing, Okla.

Also, Jos. B. Thomas, Elmwood, Ill.; M. P. Foley, Ottawa, Can.; E. H. Witt, Euclid, Ohio; Ronn Desper, Wisconsin Rapids, Wis.; Ralph Fuller, Northfield, Minn.; Harry Boyse, Lethbridge, Can.; S. E. Moore, Lancaster, Pa.; Ray Mowery, Mahanoy City, Pa.; Andrew Pura, St. Thomas, Can.; John Freeland, Franklin, Ky.; G. H. Payne, Westerly, R. I.; N. Glicksbury, Chicago.

Also, Frank Wilson, Manchester, Conn.; George Beltz, McMechen, W. Va.; S. Kenneth Barber, Wilkes-Barre, Pa.; H. D. Taylor, Raleigh, N. C.; C. E. Boardman, Santa Maria, Cal.; Chester Ellison, Reading, Mass.; Earl H. Griffin, Hillsboro, N. H.; Lester Harris, San Bernardino, Cal.; Edward Scanlon, Holyoke, Mass.; Elwyn Glynn, Cambridge, Mass.; R. A. West, Burbank, Cal.; Walter Pyle, Assiniboia, Can.; Frank Berges, San Francisco; W. Fenwick, Victoria, Can.

Also, Frank Swalbert, Buffalo; John Stauffer, Steubenville, Ohio; Henry Harding, Grant, Nebr.; Martin Teker, Leith, N. Dak.; Ed. Burse, Jr., Alameda, Cal.; Sam Teresi, San Jose, Cal.; Merle Chamerlin, Culver City, Cal.; T. Morisawa, Los Angeles, Cal.; W. R. McDonnell, St. Louis; Carmen Grillo, Lawrence, Mass.; R. A. Young, Homestead, Fla.; R. W. Kuhn, Falls Church, Va.; Joseph Plaza, East View, N. Y.; E. L. Rhodes, Brunswick, Ga.; and Lauriat du Four, S. Portland, Maine.

★ Notes From The Supply Field ★

EASTMAN FINE-GRAIN FILM

A new fine-grain film for sound recording, heralded as one of the most important developments in years, is now being used by Warner Bros. The film, made by Eastman is being used in "Hollywood Hotel" and "Swing Your Lady" and will be used in all Warner pictures from now on. The film is said to be as great a technical improvement as the introduction of gray back panchromatic film three years ago.

This new film offers much lower surface noise, much greater volume range and a more faithful reproduction of all frequencies including particularly the high notes. The higher volume is obtained without distortion.

ERPI ENGINEERING LABORATORY

Erpi has opened a new modern engineering laboratory at 76 Varick St. in New York City. Occupying more than 10,000 square feet, on two floors, the new plant includes laboratories for the investigation of problems in optics, speech transmission, sound recording and reproduction, acoustics, etc.

NEW HICKOK 4800S SET TESTER

The new Hickok 4800S set tester is a wide coverage instrument having a built-in multi-selector with a complete set of leads and adapters for socket analysis. Its zero current voltmeter gives readings of infinite ohms per volt d.c.—equivalent to millions of ohms per volt. It also reads the capacity of mica, paper and electrolytic condensers, and can be used to check audio amplification tubes.

Hickok 4800S Set Tester

Ranges cover every present need and many future requirements: d.c. volts —0/10/50/250 at infinite ohms per volt; a.c. and d.c. volts in five ranges at 1000 ohms per volt; d.c. microamperes 0/500; d.c. milliamperes in three ranges; ohms in five ranges to 10 mega., and can be read as low as .05 ohms.; five ranges of microfarads; output same as a.c. volts, and also decibels and henries.

Batteries operate all except the highest range of ohms and capacity meter, which operate from built-in power supply. Equipped with new Hickok-built rectangular meter. Has satin-etched metal panel. The walnut cage is 5" x 10" x 12¾". From Hickok Elec. Instrument Co., Cleveland, Ohio.

FOREST TRADE-IN POLICY

Forest Mfg. Corp. announces the adoption of a liberal trade-in sales policy. All theatres now using the old Forest Copper-Oxide rectifiers may now trade-in this unit, through their supply dealer, for a new Forest Magnesium-Copper Sulphide rectifier. This offer holds good only until April 1 next.

ED BISHOP NOW WITH N. T. S.

Edward W. Bishop, for the past several years with Erpi, in charge of sales in the Middle West, is now with National Theatre Supply Co., where he supervises Mirrophonic sound equipment sales for that company's Chicago, Detroit, Cleveland, Pittsburgh, Cincinnati, Indianapolis, Milwaukee and Minneapolis branches, with headquarters in Chicago.

NEW FLUORESCENT CHALK

A fluorescent chalk which glows with a strong green light and is visible at a distance has been developed recently by Westinghouse. It appears and marks

like ordinary chalk under normal light. It glows in the dark when irradiated with ultra-violet rays such as from a sun-lamp enclosed in a black globe. It provides a new tool for the lecturer who, during the showing of stereoptican or moving pictures, wishes to put a visible written message on the blackboard for his audience. This novel medium is especially valuable for use during the showing of moving pictures with sound.

NOTES ON SHORT-CIRCUITS AND THEIR MEANING

By *KURT WILCKENS*
HEINMANN ELECTRIC COMPANY

WHY should a 15-ampere circuit-breaker be tested on a short-circuit of say 5,000 amperes? Surely there is a tremendous discrepancy between rating and test amperages. Yet the reason for such a strenuous test is perfectly logical, when conditions are understood.

A short-circuit current may attain very elevated amperages. It is just a matter of the amount of current made available by the generating, transmission, transformer and wiring facilities when the normal opposition to that current is suddenly removed by a "short." The tremendous surge of available circuit must be withstood by the entire system and equipment until the current is ruptured or broken. Assigned to that job of breaking the circuit, the circuit-breaker has to withstand the arcing and even explosive effect resulting in the rupturing of the very heavy amperage. The safety of the guarded equipment, wiring, and even life and property, rests upon a clean-cut break made in the least possible time.

To appreciate the real significance of a short-circuit, let us take the good old anology of the water pipe. If we accidentally break or cut a 12-inch main, there will be an enormous volume of water released, with correspondingly serious damage if out of control. It may be difficult to curb that leak unless a dependable valve is near at hand to turn off the water supply as promptly as possible. On the other hand, the accidental breaking or cutting of a 1-inch pipe releases comparatively little water and does a modest amount of damage. A small valve may serve to turn off the flow.

Time Element Important

We note, therefore, that it is the *available flow* of water through main or pipe which determines the seriousness of a sudden leak. And so it is with an electrical short-circuit. It is the *available current* that can be passed by transmission line, transformers and building wiring that determines just how serious a "short" may be, if said trouble is not promptly and completely interrupted by a circuit-protecting device.

The time element plays a most important part. A given motor may be protected by a 5-ampere circuit-breaker. Between that breaker and the transmission line outside, there may be two or three breakers or fuses of higher amperage ratings. If a "short" occurs on the load side of the 5-ampere breaker, that breaker must withstand the brunt of the full amperage available even though but for an instant, for it should trip and break the circuit before the higher-amperage devices in the line.

The higher-amperage devices come into action only if the lower-amperage devices have failed to function. Upon the speedy operation of the breakers depends the real protection of equipment, since such equipment is subjected to the full available current until the circuit can be ruptured.

In the usual house wiring, for example, there is a limited current flow to contend with, especially on upper floors or remote spots from the service entry. The wiring provides sufficient resistance drop to short-circuited current. Also, the transformer capacity in the case of a.c. keeps the current down to relatively safe proportions. But in an industrial plant where many motors and other equipment call for heavy am-

perage, the transformer capacity and the building wiring are such as to permit a current of hundreds and even thousands of amperes to be turned loose in the presence of a "short."

In industry a blown fuse represents an item of cost. Such a fuse must be replaced. This means time out, searching for the blown fuse and replacing same. Since minutes and even seconds count, the expense represented by the loss of time is justifying the trend towards circuit-breakers. These automatic, resetting devices are being placed close to the actual equipment to be safeguarded, so that operators can throw on the current if the overload condition no longer exists.

Circuit-Breaker Applications

Particularly in the protection of critical equipment is the fully-magnetic type circuit-breaker essential. Many kinds of equipment call for high current drain at starting. Gas-filled incandescent lamps, for instance, require as much as ten times normal current at starting, but an instant later drop to normal. Quite obviously, then, the circuit-protecting device must allow this high starting current to pass through for an instant, and after that be ready to interrupt the current if it continues at the abnormal level. This is where the time-delay action circuit-breaker comes in. We now have precise circuit-breakers available which allow for a current of several hundred per cent for a few seconds up to a few minutes, depending on the load requirements, yet instantly trip on a "short" or a current surge of, say, 800% or over.

AS ONE OLD-TIMER TO ANOTHER

(*Continued from page* 23)

at least as long as Brother Klingensmith. I received my first operator's license in 1911. I, too, have run the old Powers 5 and the Edison Kinetoscope. I have run the old two-pin Edison with the single-blade, mica shutter and the "pump—handle lamp." I ran some of the first Powers 6 machines in Los Angeles. At that time I constructed a variable speed motor drive for a Powers 5 which was similar in many respects to the drive that Powers later brought out on the 6-A.

No Short-Cut to Knowledge

Brother Klingensmith is mistaken when he says "members who have been blessed with a complete understanding of things." Those of us who do know some of the finer points of projection have not been "blessed" with that knowledge. We all started from scratch and *worked* to learn the finer points. My own knowledge was obtained by *constant* study from the time I first turned a crank, and before then. He surely flatters us when he says *complete* understanding.

The Brother is a bit inconsistent. He

objects to the term "button-pushers," but in an earlier paragraph he himself says we were just a "bunch of crank-twisters." Both terms are very descriptive, and were used for that reason. Brother Klingensmith bemoans the fact that the lack of an elementary schooling deprives a man of the chance to learn later on in life. This is one of the usual excuses; another is the statement that "I am too old to learn." Neither of these is true.

One of my best friends did not go beyond the fifth school grade. He was practically illiterate. We had not seen each other for years, but recently we were thrown together again. I was surprised to see him handle mathematics with ease, and not grammer school math., either. He is one of our foremost projectionists and is well up on sound. He has found time to become an accomplished gas engine mechanic *and* machinist; he has learned navigation. This was all done since his thirtieth year! I, personally, am learning more now than I did in my younger days, and I am within hailing distance of the half-century mark.

Apparently the Brother read my article quite thoroughly. This must have been caused by either curiosity or resentment, or *by a desire to learn!* In any event, if he keeps this up he *will* learn. The trouble is that it takes so very much reading, unless he combines practice with it. That is the stumbling block with most men: they are willing to do all the reading necessary, but they refuse to do the actual work that will make the reading bear fruit. The difficult part of the practice end is to start. When I was a kid working in a drygoods store, my boss told me that the only hard part of any chore was to get started. The way to start is to start.

Brother Klingensmith practically agrees with everything I said, so this should be considered as a discussion with a desire to establish a mutual understanding. As he says, it is not only the old-timers who fall short of the standard. In my opening paragraph I said: "There is so much more to projection that probably none of us knows all about it." That includes *all* of us. The article did not intend to show what the average projectionist knows. The idea was to set a level for us to shoot at, *a level which we will be required to reach some day.*

Shooting For the Stars

As stated in my last paragraph, the article was the *writer's* idea of what a projectionist *should* know. Incidentally, that last paragraph carries a lot of food for thought. I believe readers will profit if they read the last ten lines over slowly, one sentence at a time.

THE PLACE OF TELEVISION AMONG THE VISUAL ARTS

(*Continued from page* 22)

cross-section, but spreading and persistence of image reduce definition at the receiving end. And, all along the line from original pick-up to final reproduction, we encounter electrically disturbing elements which tend to "degrade" or reduce the fidelity of the reproduced image.

Delay in Transmission

In the present state of the television art, the definition obtainable is only a minor fraction of that direct vision or of motion pictures, but it is nevertheless adequate for many purposes, including certain types of mass entertainment and education.

Another element of interest is the necessary *delay*, measured between the time of original pick-up and the time of final viewing by the looker. In the case of vision, there is no delay, the pick-up process and the actual vision by the looker coinciding (except for a brief lag in the brain paths). In the case of motion pictures there is always an appreciable delay. The most speedy viewing of film after exposure appearing in the literature is that of the so-called intermediate-film process applied to television reception with large-screen projection. Here the film is used to record the incoming television pictures and is de-

veloped extremely rapidly, fixed, and projected (a positive being produced immediately by deliberately arranging for the reception of a negative—which is a mere matter of phasing).

It has been claimed that from a few seconds to, say, thirty seconds elapse in this case between reception of the television picture and projection of the corresponding motion picture film. However, about the most rapid commercial procedure involving the making of a number of positive prints from an original negative is that of the newsreels, and this process may take anywhere from one to three hours. Where haste is not so essential, as in the case of feature films and short subjects used for motion-picture entertainment, the delay may run from weeks or months to years! Thus the motion picture in its more evolved forms pays a fairly high price for the permanence of its records in the form of a delay in their production and reproduction.

Television can adapt itself to either the visual or the motion picture limitations and possibilities in this respect. Ordinarily television is instantaneous where a direct pickup is used. If film is used for television transmission, the delay is that inherent in the filming process and is as brief or as prolonged as corresponds to the particular photographic and film-processing methods which may be employed.

A factor of considerable practical importance is the *dependence of transmission* on the instant of *occurrence* of an event. So far as ocular vision is concerned, a real event can be seen only at the instant of occurrence (leaving out of consideration such relativistic questions as the actual time of viewing a star explosion in a distant part of the universe). Accordingly all the historical past is lost so far as direct vision by human beings is concerned. The motion picture suffers from no such limitation. It is true that there must be light with which to photograph the event and that the film support and the image carrier and constituents must be of suitably permanent nature.

However, granted these reasonable requirements, the motion picture may be made at any time and shown at any later time. In fact, the motion picture has one curious characteristic: it can show things that never happened, as in the case of animated cartoons and trick photography. The nearest approach to this in direct vision is the deliberate distortion of a view by means of colored glasses, distorting lenses or reflectors, or the like. These means for modifying an actual view are relatively limited in their scope as compared with the possibilities of imaginative picturization accomplished by the motion-picture film.

Television with direct pick-up of an actual event is just as dependent on its time of occurrence as is the eye. However, if the pick-up is by motion picture and the transmission is by television, or alternatively if the pick-up is by direct television and the received images are recorded on film, we again have independence of the time of reproduction relative to the time of occurrence of the original event. Thus television is happily able to borrow the technique of either the eye or the camera and thus to expand its own capabilities in accordance with the needs of the situation. This will obviously be a great convenience, since the pick-up of a football game, for example, may be at a time of reduced available television audience, thus making it desirable to repeat the television transmission of the game from a film record at a later time.

Time Transpositions

A practical factor of considerable importance is the possibility of *time transpositions.* With natural vision, we are compelled to observe things in the order in which they occur. In fact, we can only observe that instant which is the present and which forever merges into the immediate future and departs from the near past. The motion picture is

entirely unhampered in this respect. A number of pictures can be made in any desired sequence, and can then be re-arranged and assembled in any other new sequence. The familiar "flash-back" of the motion picture is a striking instance. Here action, presumably in the present, is interrupted by scenes from the past, after which the picture continues again in the present or even takes an imaginary trip into the future.

This possibility of time transpositions has always been a great asset for the motion-picture producer. The scenes of a play can be photographed in any desired order, but can be cut, edited, or re-arranged in such a way that they are presented to the audience in quite a different order which may be artistically more attractive and dramatically more striking. This also leads to economy in production since all scenes taking place in given surroundings can be photographed in one sequence regardless of their apparent time of occurrence in the finished film.

Television with direct studio pick-up is rather handicapped in this respect, just as is direct vision (or, for that matter, a particular act in the usual leisurely legitimate-theatre production). It is only when television enlists the aid of the motion-picture film, either for background projection, in the production of composite pictures, or for the entire presentation, that it partly or entirely acquires the great advantages which result from the possibility of time transpositions. Since, however, there is no scientific reason why television should not use motion pictures whenever desirable, the motion-picture technique of time transpositions could, to a considerable extent, be effectively utilized by television.

All of the foregoing leaves little doubt that television is so flexible, convenient, and eclectic a method of visual reproduction that it will have general human appeal and wide-spread application. Carrying within itself for the first time all the possibilities of both the eye and the camera, it seems destined to be one of the great instruments of universal human enlightenment and progress.

The Proper Use of Illumination Terms

(*Continued from page 17*)

lumination," "raise the illumination," "too low illumination." Obviously when the context implies quantity, there can be no doubt as to which meaning of "illumination" was intended.

'Intensity' As a Synonym

As an outgrowth of the use of the questionable expressions "illumination intensity" or "intensity of illumination," a few writers have gone so far as to use "intensity" as a synonym of "illumination." This practice was first called to the writers' attention by an engineer who objected because "intensity" suggested to him something extreme or disagreeable, as in "intensity" referring to heat or cold. The leading dictionaries give a surprising degree of support to this view.

Since increased illumination in artificial lighting practice generally results in greater comfort and pleasure, this connotation of "intensity" should be undesirable, especially to those interested in promoting more liberal provision of illumination.

However, in addition to this, "intensity" has been preempted by the Society for another purpose, so that its use in place of "illumination" is liable to misinterpretation. The Society defines "luminous intensity" as the "solid angular flux density" of a light source in a given direction, in other words, the quantity which is measured in candles . . . It seems proper, therefore, to say that the use of "intensity" as a synonym for "illumination" is . . . liable to lead to misunderstanding . . .

There are a few instances when some sort of an expression is desirable to indicate "illumination" in the quantitative sense rather than in the general one, and some additional words are justified for this purpose. Among those most commonly used are "intensity," "level," "value," "amount," and "quantity,"

either in such form as "level of illumination" or "illumination level." While "intensity" used in this connection is not liable to misinterpretation, the use of "intensity" in so fundamental a sense as in "luminous intensity" would seem to militate against the good taste of this usage.

"Level of illumination" seems to suggest a level curve, indicating uniform illumination and would seem to be applicable only for this purpose where such a condition exists. In such cases as local lighting, supplementary illumination, and street lighting the illumination varies considerably from one point to another, so that "level" would hardly seem descriptive. In some instances there have been ambiguities as to whether "level" referred to the illumination or to the plane on which it was measured. So its use should be with caution only.

There appear to be no objections to "amount" or "value" and the use of one of these is suggested for those instances where an additional qualifying term is needed for clearness . . .

CRAFT TRICKS AND TROUBLES IN B.S. PROJECTION ERA

(*Continued from page 8*)

technique by threading in from ten to twelve seconds regularly and starting the picture *in frame*. This trick, which baffled the boys, was done on a Powers 6 by threading as usual, starting to turn the crank *slowly* with the douser open, but the fire shutter closed for a moment. Meanwhile I noticed where the frame line came at the top of the gate, and moved the framer so the line was in the right position. Increased pressure on the crank immediately lifted the fire shutter—and there was the picture in frame. The "secret" was short-lived, however, for the boys did a little calculating and the jig was up.

All the old machines (as far as I know) had two bearings for the intermittent shaft. We were told that it was important to keep the intermittent shaft and the camshaft perfectly parallel, which was accomplished by calipering the distance between the shafts. This seems comical now.

Although the instructions were correct, none of us could use calipers properly or knew enough about mechanics to make the adjustment and be sure of good results. At that time I knew two projectionists, machinists by trade, who were capable of doing this job properly. The rest of us might better have not tried it, in the interest of preserving the machines.

One who uses calipers regularly can measure down to .00025 inch, which is closer than would have been necessary. None of us, excepting the machinists, could measure much closer than .003 inch at the time, hardly accurate enough. Then, too, we probably did the bearings no good when we twisted the eccentric bushings indiscriminately, although they may have been so worn as to have not been affected.

At that time the Powers machine had two pad rollers on the lower sprocket, carried on an auxiliary bracket which was swiveled on another bracket. This being hard to adjust, it was discontinued. I wonder how many present projectionists ever saw this one.

Many parts on this machine were potmetal, and quite a few broke. This swivel bracket broke on us one night after the exchange had closed, and no parts were obtainable until the next day. A wire rig was made to hold the pad roller in position. Another time one of the links for raising the fire shutter broke. This was soldered together, a haywire repair that lasted for a long time before being replaced.

The tension on the upper reel was a joke. It was not thought necessary to have much of a device here. Of course, it was not so serious then, because we ran only 1000-foot reels, which were the small sheet metal affairs with a small hub. Not enough weight or inertia was present to matter. The take-up also did not require a very elaborate arrangement. What worried us mostly regarding the take-up was to make it run easily, so that cranking was less tiring. After we started using motors even this did not matter, and very little attention was given to the take-up until we started doubling reels.

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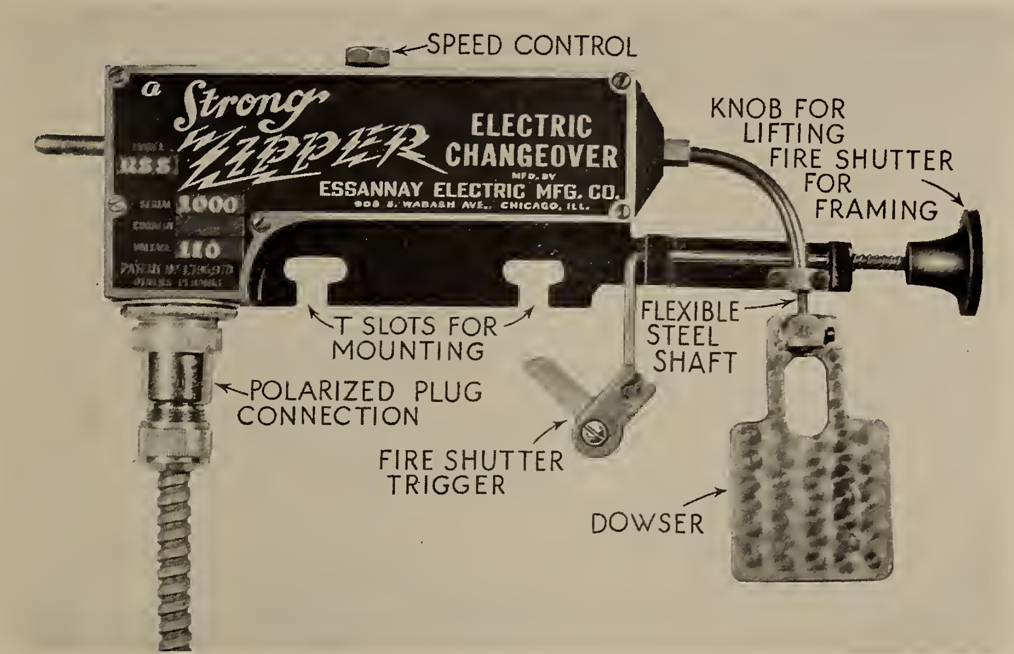

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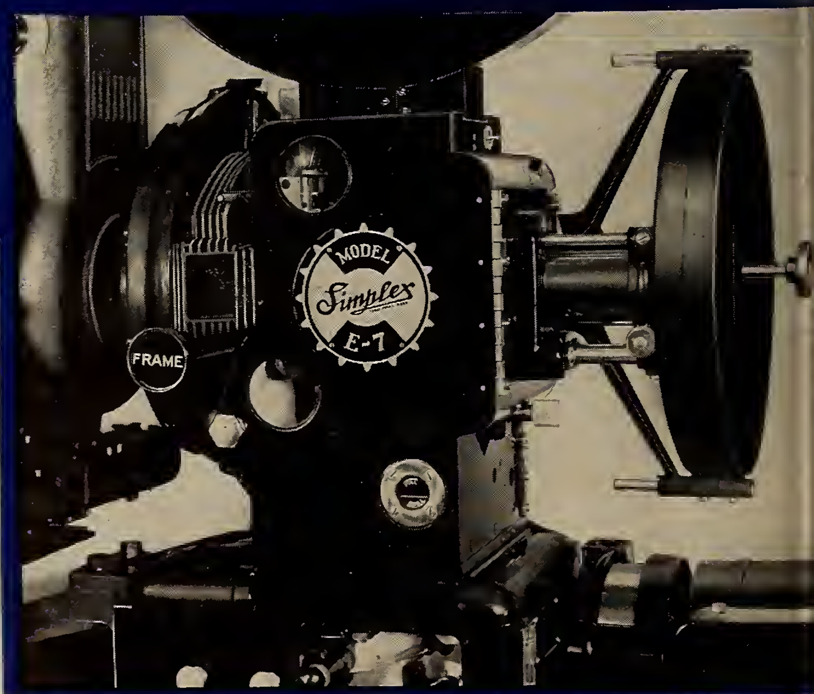

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PROJECTIONIST

MARCH 1938

VOLUME 13 • NUMBER 3

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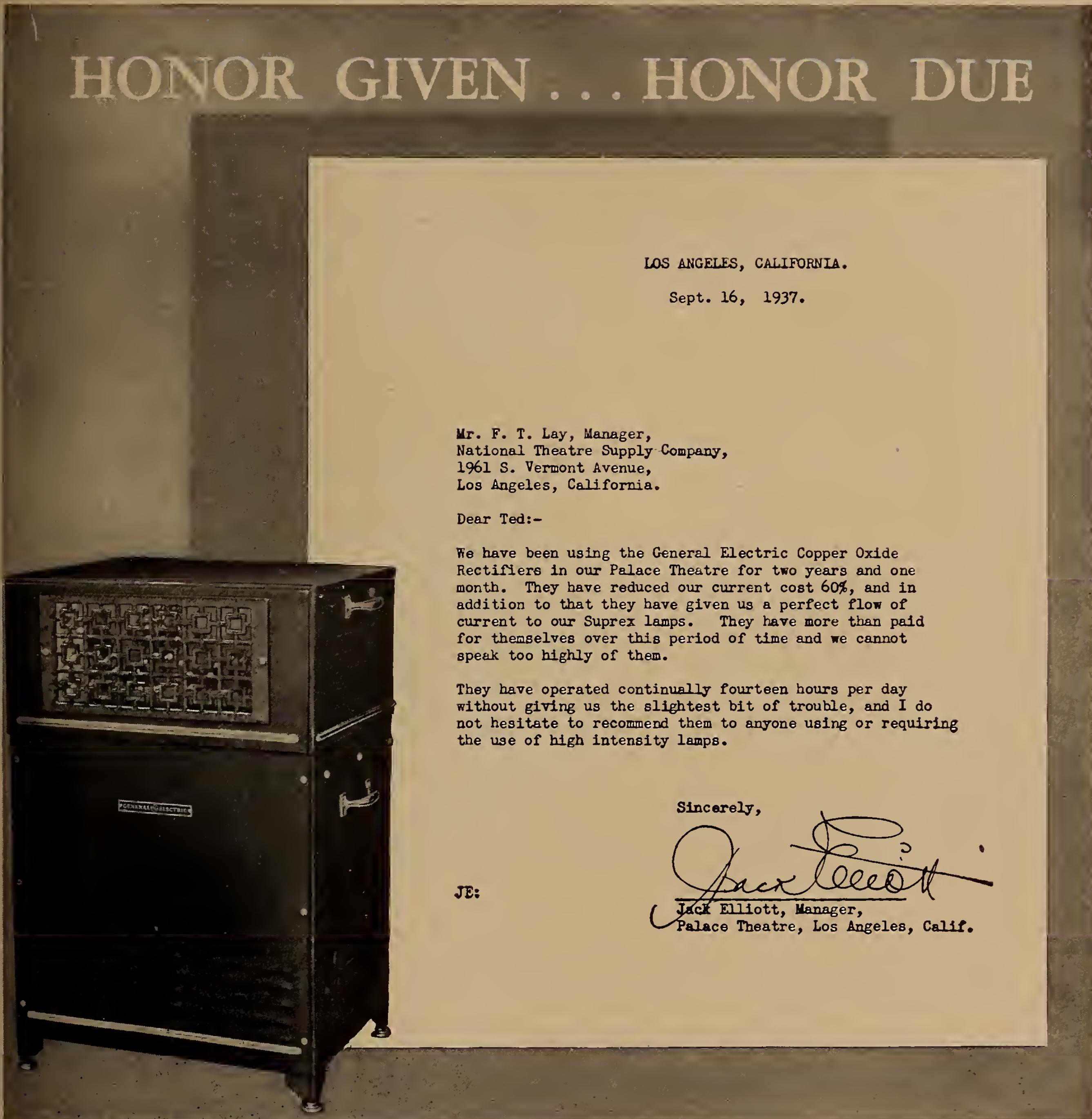

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With Which is Combined PROJECTION ENGINEERING

Edited by James J. Finn

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MONTHLY CHAT

PROJECTIONISTS have long railed against the condition of release prints, but to date these indictments of producers, of distributors and, in particular, of exchanges have been as productive of results as are metal mirrors. Of late, however, we seem to be getting somewhere—or are we? A few yelps anent specific faults in prints from specific companies plus the circulation among those mentioned of tear sheets with bold red markings thereon, and lo, the response is not only immediate but highly gratifying to the harassed "man behind the gun."

When a producer boards a train and rides two hundred miles just to soothe the ruffled feelings of a Local Union official on the score of poor print condition, then we are warranted in saying that things technical in this business are definitely on the upbeat and in holding high hopes for the future. At last producers are taking a pardonably jealous interest in the final presentation of their product, even if the guy who has most at stake, the exhibitor, still thinks of show business strictly in terms of superficialities.

OLD but true is the Suprex arc story, and it has been broadcast to the far reaches of the exhibition field. Suprex operating average two cents an hour, at most, more than the low-intensity arc. One extra admission per show for about one and one-half years will cancel out this difference and go far toward amortizing the cost of new Suprex equipment. And right at this point the comparison between the two arcs reaches a dead end.

If there be any basis for the projectionist claim that he exerts a potent influence in the equipping and maintenance, as well as the operation, of a projection room, now is the time to step out and prove it—and with a really meritorious unit. We've finished this little essay; and so are youse guys what is still plugging those l. i. arcs.

THE sponsor for a "new" screen told us the other day that in a recent test his screen gave 30 per cent "more light" than did another well-known brand. Which prompted us to ask just two questions: What type was the latter screen? What were the physical characteristics of the auditorium in which the test was made? These questions were not answered satisfactorily; but if they had been, we should have discovered that the "new" screen was super-excellent to the tune of 130 per cent efficient. You figure the rest.

THE S.M.P.E. Convention scheduled for Washington, D. C., beginning April 25 merits the attendance of all those Eastern fellers that can possibly attend. The Society is doing good work and has been and is particularly keen on practical projection problems.

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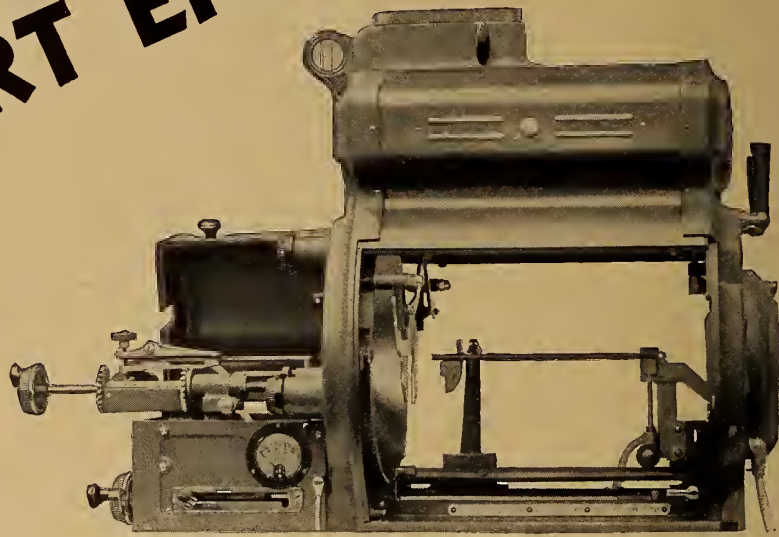

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INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 3

MARCH 1938

The Geneva Intermittent Movement: Its Construction and Action

By *A. C. SCHROEDER*

MEMBER, PROJECTIONIST UNION 150, LOS ANGELES, CALIFORNIA

THE Geneva intermittent movement is used in all modern theatre projectors, although claw-type movements are used in studios for process work. The Geneva movement changes continuous rotary motion into an intermittent motion, the camshaft turning at a uniform speed, while the intermittent sprocket stands still part of the time and moves very rapidly the rest of the time. The intermittent must transport about eight inches of film a distance of ¾ of an inch at an *average* speed four times normal, and stop each frame in exactly the same position at the aperture.

Slot Engagement by Pin

When moving at a uniform speed (as it does on the upper sprocket), each frame is in motion four times as long as it is when in motion at the aperture. The *average* film speed at the aperture is four times normal, or 360 feet per minute. Due to inertia, the film, the sprocket, and the intermittent shaft must be brought up to this speed gradually, consequently the maximum speed must exceed 360.

In Fig. 1 the pin is shown at the instant it engages the slot in the star: exactly one-half the pin is in the slot. Until this moment the star has not moved. A represents the cam center and B the star center. A, the center of the pin, and B form a right-angle, as the dotted lines indicate. The arrow indicates the direction of the pin travel for an infinitesmal fraction of time at the exact moment it engages the slot. Notice that the pin travel coincides with the direction of the slot, consequently there still is no star movement.

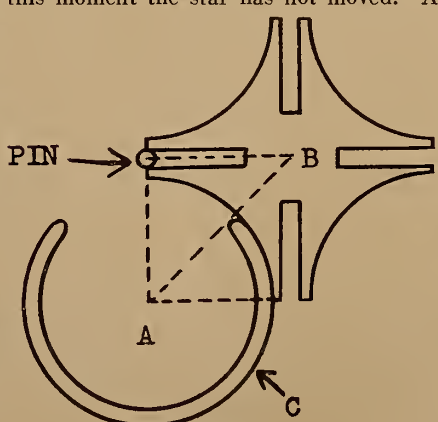


FIGURE 1

This holds true only for the shortest possible moment, *immediately* following which the star begins to move very slowly, but the acceleration constantly increases until the cam has turned about 30 degrees. The speed of the star and consequently the film, is still increasing even after 30 degrees of cam rotation, but the *rate* of acceleration has decreased.

Figure 2 shows the movement when the speed of the star is greatest but acceleration has stopped. The pin is in line with the shaft centers, A and B, and is comparatively close to B. For a *brief instant* the pin and the sides of the slot act nearly like gear teeth. The radius of the corresponding large gear would be the distance A to the pin center; the radius of the corresponding small gear being B

to the pin center. Since the latter is much less than the former, the star is turning *at the rate* of many more revolutions per minute than the cam.

As the pin leaves the position of Fig. 2 the star, the sprocket, and the film be-

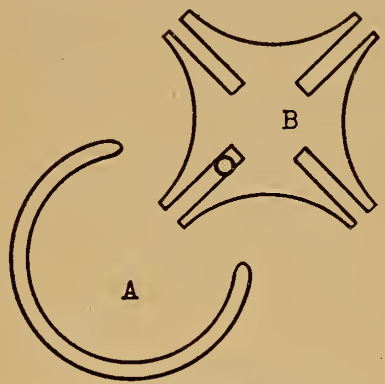


FIGURE 2

gin to *de*celerate. This part of the cycle is as important as the first half. If the parts fit and are adjusted so that operation of the first half cycle is perfect, the conditions will also be correct for the last half. If the parts fit poorly, the tension shoes must decelerate not only the film but also the star, its shaft, and the sprocket, at least part of the time between the position of Fig. 2 and completion of the film transfer, thus putting an enormous load on the sprocket holes and preventing proper positioning of the film at the end of its travel.

The star, its shaft, and the sprocket, having attained such a high speed at the 45-degree position (Fig. 2), tend to maintain that speed, but the cam pin prevents this, forcing the star to gradually slow down. Immediately following the position of Fig. 2 the deceleration is low. The *rate* of deceleration then *increases* (remember the pin is decelerating the star all this time). The rate of deceleration *decreases* toward the end. The star is almost stationary when the pin is about to leave the slot.

The lock ring (C, in Fig. 1) contacts the curved portion of the star snugly, thus holding it in position while the film is projected on the screen. The end of the lock ring is approximately at line A-B when the pin enters the slot. When the end of the ring is above this line, the star cannot move in either direction. As the pin proceeds farther into the slot, the end of the cam ring moves down and away from this line, allowing the star to turn, as Fig. 2 shows.

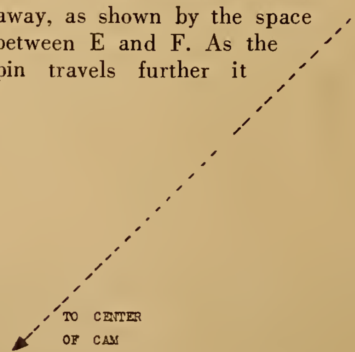
If the lock ring extends beyond the dotted line when the pin enters the slot, the star is still locked, while the pin exerts pressure on the star attempting to turn it, and the movement will not work. If the lock ring does not extend to the dotted line when the pin is in the position of Fig. 1, the star is free to turn before the pin enters the slot, and the pin might strike the point of the star, thus wrecking the movement.

We can now study the possibilities of a faster movement. In the ordinary movement the cam and pin turn through 90 degrees while the star and sprocket move the film one frame. To increase the speed of the movement we must allow less than 90 degrees cam rotation to complete the star movement. The pin still enters and leaves the slot at the same two points, and to do this in less than 90 degrees the cam center must be farther away, decreasing the angle A, as shown by the dotted lines in Fig. 3.

The corresponding angle in Fig. 1 is 90 degrees. Notice how much smaller this angle is in Fig. 3. The arrow in Fig. 3 shows the direction of the pin travel as it enters the slot. Notice that it does not correspond to the direction of the slot, as it did in Fig. 1, resulting in the pin contacting the slot with a bang, and the star *immediately* turns at a certain finite speed: a miniature collision occurs and the shock is transmitted to the film. This extremely rough treatment soon shows not only on the film but on all the parts, including the cam pin. The larger the cam, with the same size star, the harder is the impact. If both the cam and star are larger, in proportion, there is no increase of speed, although the parts are more able to stand the strain imposed on them.

Another problem enters the picture when we increase the cam size. To illustrate this we make the drawing as though the cam were inordinately large in proportion to the star, as in Fig. 4: the three solid lines represent the side and end of the slot, the circle represents the pin, and the dotted line with the arrow at the end continues on to the cam center. The lock ring is not shown.

Arrow D indicates the direction of pin travel at this instant. Note that the pin just clears the upper edge of the slot; but E, which is closest to the lower edge of the slot, still is some distance away, as shown by the space between E and F. As the pin travels further it



again *leaves* the upper edge of the slot and the distance E-F becomes less, until we reach the position in Fig. 5, showing the instant that contact occurs.

Arrow G indicates the direction of the pin and shows the point of con-

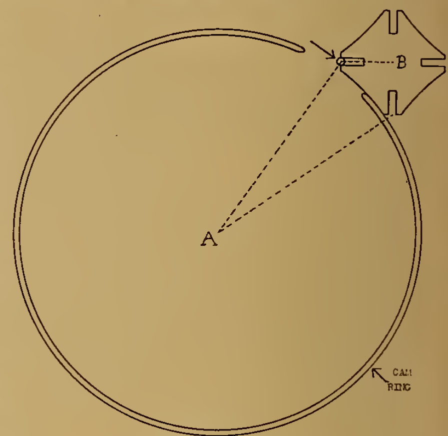


FIGURE 3

Notice that radius on sides of this star is much greater than in Figs. 1 and 2; also slots are not so deep, due to large cam and the larger circle in which pin travels

tact. The distance between the pin and the upper edge of the slot has increased to H-I. The lowest extremity of the pin is now *below* the lower edge of the slot, as the dotted line indicates. One might say that the pin has moved ahead of the star, so the star must snap ahead at a terrific speed, *instantly*, to make way for the pin.

Since the pin is positively driven and cannot rebound, this impact causes the star to rebound, resulting in again opening a space at G. What occurs next depends upon the weight of the star and associated parts, the weight of the intermittently-moving portion of the film, and the friction due to the tension shoes. With heavy parts and light tension the

FIGURE 4

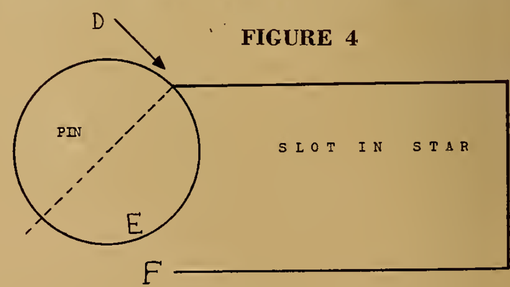
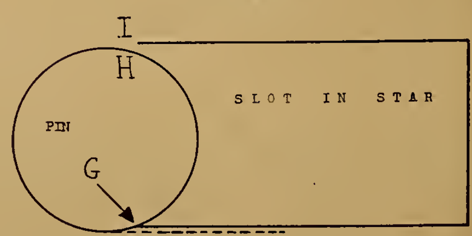


FIGURE 5



star flies ahead until it "catches up" with the pin, resulting in contact of H and I, with the possibility of another rebound

'A Slight Case of Murder'— in the Projection Room

By *THAD C. BARROWS*

PRESIDENT, PROJECTIONIST LOCAL 182, BOSTON, MASS.

THE title of this short article is clearly an infringement of the copyright held by Warner Brothers on one of their current releases; but judging by the scant regard paid by this company to the condition of their release prints, I assume that they care little about their property and that no action will be taken against me.

Last month I enumerated many instances of carelessness on the part of producers with respect to release prints, the correction of which abuses would entail little effort and practically no expense by any branch of the industry, while at the same time enabling projectionists to really merchandise these pictures. The response to my article was highly gratifying: while projectionists would naturally be expected to approve, the number of comments thereon received from far and near was indeed surprising. This response indicates to me not that the article was a literary masterpiece, nor that it contained any startlingly new data, but that projectionists are weary of promises and are determined to state their case emphatically —and then let the producers worry about results.

It appears, however, that we are finally getting somewhere on this print situation, because my article induced responses from several exhibitors, from one circuit home office and from a producer. Mr. A. J. Richards, editor-in-chief of Paramount News, came to Boston, discussed in detail the various points concerning his reel, assured me that constructive criticism is always welcome, and stated positively that he wants the co-operation of projectionists. Evidently what this business needs is a few more producers like Mr. Richards.

Some of my correspondents considered my remarks a bit caustic, and possibly a trifle unfair to certain producers. I regret that this impression was conveyed, because I confined myself to factual statements.

The title of the present article seems to me very apropos in the light of what follows. If there be any doubt among I. P. readers as to the plausibility of the following statements, I can supply enough affidavits to paper a projection room.

Shades of Disc Reproduction!

On March 10 at the Metropolitan Theatre in Boston there was held a preview of "A Slight Case of Murder," a First National production released through Warner Brothers. Apart from the usual fader jumping of from one to eight points and the usual quota of that good old Warner edge-waxing, things went along all right until the latter part of reel 4, wherein Edward G. Robinson and his colleagues discover the money that had been hidden in his home. From this point on through three scenes were heard not the voices of the characters shown on the screen (especially when Robinson is telephoning) but entirely different voices and sounds. What happened? Not a thing—except that the wrong sound track was printed on the film!

Now, who took the panning for this piece of stupidity? The producer? No. The exchange? No. The booker? No. The theatre manager? No. You guessed it—the projectionist! Just try to absorb the explanation offered for this lapse in projection—the projectionist PUT ON THE WRONG RECORD!

That's how remote is the distribution-exhibition field from the technical realities of their own industry. We haven't been using discs for almost ten years, yet the charge against the projectionist is that he put on the wrong *record!* It's about time that Warner Bros. faced the fact that there is something radically wrong in their laboratory procedure—if only on the score of persisting in using edge-waxing, when every other major producer, every outstanding projection man, *and* the engineering and technical societies, condemn its use.

Not mentioned previously herein but still fresh in my mind is the laboratory work on Paramount's "The Buccaneer," the fine entertainment of which could have been messed up by so simple a matter as faulty change-over marks. Near the end of one reel there appeared the conventional warning dots; forty frames further on there appeared another sets of dots—the theory evidently being that the first set would wear off.

And so proceeds the world's fifth largest industry on the technical front, the while it expends astronomical sums on production, on distribution, on exhibition and on ballyhoo to get people into theatres—only to cheat them on the admission price when once they are inside. We're all plugging away at making a living in the industry, but it is strange that the impetus for correction of such glaring faults should have come from that group which would be expected to take the least interest therein—the projectionists.

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here. The pin will now be far enough into the slot to prevent further erratic action, such as rebounding.

On the other hand, with very light parts and relatively heavy film tension, H and I will not touch; but the second contact occurs at G, where there is possibility of another rebound.

The degree to which the foregoing action takes place depends upon the speed of the movement. If the speed is only slightly above normal (3-to-1), rebound might not occur because of the lighter impact at G. The direction of arrow G would more nearly coincide with the direction of the slot. Also, the pin would be practically half way in the slot when contact occurs, thus stopping any tendency to rebound. However, there still is a sudden jar in any *conventional* movement where the speed has been increased beyond the 3-to-1 ratio, and the effects will be seen on the parts and the film.

In this discussion an intermittent in which the transfer of film is completed during a cam rotation of 90 degrees is termed a 3-to-1 movement. This same intermittent is sometimes spoken of as a 4-to-1 movement. This is apparently due to considering the ratio of the entire circle, 360 degrees, in relation to that part of the circle during which the pin is moving the star, or 90 degrees, which gives a ratio of 4-to-1.

The writer prefers to consider the ratio of that part of the cam rotation during which the star stands still, or 270 degrees, in relation to the part of the cam rotation during which the star moves, or 90 degrees, giving a ratio of 3-to-1.

(TO BE CONTINUED)

SMPE AT WASHINGTON APRIL 25-28; EQUIPMENT EXHIBIT

The Spring 1938 Convention of the Society of Motion Picture Engineers will be held in Washington, D. C., April 25-28 at the Wardman Park Hotel. A fine papers schedule will be only one feature of a program which will also include an apparatus exhibit, numerous trips to places of interest and the usual social program for men and women.

Manufacturers are urged to exhibit their new equipment, restricting their exhibits, however, to equipment that is either newly developed or possesses technical features of interest to the engineers. No charge will be made for exhibit space. Those desiring to exhibit equipment should communicate as soon as possible with the General Office of the Society at the Hotel Pennsylvania, New York, N. Y.

Co-operation as the Keynote of Efficient Projection Service

By *T. P. HOVER*
WARNER'S OHIO THEATRE, LIMA, OHIO

MANY changes have occurred in the motion picture industry since the arrival of the first practicable projectors. However, two outstanding objectives remain unchanged and are of vital interest to the exhibition branch of the industry. The most important is that projection equipment be maintained at the very highest efficiency at all times. Almost of equal importance is the fact that such maintenance should be carried on at a price within reason.

Methods of solving these problems when motion pictures were in their infancy differed somewhat from those of the present day. A breakdown of the single projector meant long weeks of waiting for repair parts, which only too often did not even resemble the originals and sometimes never did arrive. Manufacturers of equipment were not entirely to blame, for if they attempted to "sell" the idea of parts or repair service, the suggestion was often greeted with the attitude that perhaps the machine was not so good in the first place if provision had to be made for its repair.

Minimizing Breakdown Effects

The simplicity of design and construction of many of the older types of projectors often assisted the ingenious projectionist. In 1926 the author was called upon to check over a Powers projector to which had been applied successfully repair parts from a lawn mower, a sewing machine, a gas engine, an alarm clock, and a revolver. The great precision of modern equipment has definitely obviated these haphazard sources of repair parts. High-speed communication and transportation have been of great assistance to the exhibitor. Standardization of parts and wholehearted cooperation from equipment manufacturers have also been helpful factors.

One of the most serious causes of annoyance and loss of revenue to the exhibitor is the class of trouble broadly referred to as "breakdown." No equipment is free from the likelihood of breakdown, and the only remedy is a maintenance plan that will reduce the probability of its occurring and a carefully planned repair program that will bring back into operation the affected equipment with the least expenditure of time and money. So much has been said and done on the subject of maintenance and service that they will not be discussed here further, but the problem of emergency repairs will be given considerable attention.

Approximately fifty cities in the United States have supply depots and theatrical repair shops giving 24-hour service. Emergency repairs in those cities resolve themselves largely into procuring and installing damaged parts, which can usually be done in less than an hour. For theatres located even short distances from repair facilities, an entirely different problem appears. Telephone or telegraph may instantly connect the exhibitor with the nearest available source of repairs, but the transportation of the parts, which even at best may take from four to twenty-four hours, is an important item.

***No stranger to I. P. readers, T. P. Hover again weighs in with a fine contribution anent plans and ideas that have aided in maintaining high standards of projection in a small city 150 miles from the nearest parts-supply company. His current effort, originally given before the S.M.P.E., details effectively the steps taken by the Union to engender good will not only with exhibitors but also with the townspeople generally. Success of the plan recommends it to attention of other projectionist groups.*—Editor.**

A solution of this problem has been worked out in Lima, Ohio, by the projectionist members of the local Union. The average city of any fair size has facilities within it for making almost any repair that may be necessary to keep the picture on the screen until the proper parts arrive from the factory or a serviceman can bring them. In order to be available at a moment's notice, these emergency facilities must be properly recognized and coordinated. The keynote of the system must be cooperation between the exhibitor, the projectionist, and the holder of such facilities.

The projectionist who will devote a small part of his time to "selling" his fellow townsmen on the idea that his work of projecting pictures is a profession entailing scientific knowledge and accuracy, will find that he has driven an entering wedge into his problem.

The most important prerequisite of emergency service is the possession of the proper testing equipment and tools. Through careful planning within our organization, members seldom buy equipment of types already held by other members. Ten members of an organization each buying a $100 amplifier analyzer and test kit, will have available only $100 worth of test apparatus in the event of an emergency; but the same ten members, with proper planning, can have available a full $1,000 worth of modern equipment ranging from tube-tester, oscilloscope, vacuum-tube voltmeters, all the way to complicated vibration analyzers.

The fact that some of the larger chains have made available to their engineers a quantity of laboratory testing equipment is ample proof that the investment is justified. Our own group, through careful buying, has available almost $5,000 worth of precision equipment. Included in the equipment are a number of complete portable amplifiers, which, in the event of a breakdown could be immediately hooked up to any projection room in the city.

Local Radio Tie-Up

It should not be thought that this equipment has been purchased for exclusive use in projection rooms, for the income available from such equipment when so used would not justify the expenditure. For instance, the projectionist may add to his income by renting out public address systems, which have been constructed to handle practically any photocell input. Such equipment obviously, is available also for emergency service work. The availability of this equipment means that any amplifier or loudspeaker breakdown can be completely remedied in less than thirty minutes.

In the event of minor amplifier re-

pairs, such as of defective resistors or condensers, a local radio parts company provides day or night service in return for our permitting them to mention in their advertisements the theatres that use their brands of vacuum tubes. Those who have attempted to arouse a parts supplier at night in order to get an elusive amplifier part, can readily appreciate the importance of reliable day and night service.

Mechanical troubles offer the possibility of the most extended shut-downs. While a reasonable quantity of spare projector parts is usually carried, breakdowns often occur in which gears are damaged or shafts bent in such a way that factory replacement is almost necessary. Records of ten years of mechanical breakdowns have shown that 95 per cent of such breakdowns are the result of using cheap, mismatched, or so-called bootleg repair parts.

Our organization has effective a cooperative tie-up with a local company specializing in the manufacture and repair of motors. All regular motor repair work of the theatres is done by this one company. In return, a machine and electrical shop that is a veritable mechanic's paradise is open to the use of our members. This company also maintains a research department and has portable welding and brazing equipment and a portable power and lighting unit, which is also at the disposal of our members. As the shop runs 24 hours a day, its facilities are always available.

Recently the main drive gear of one of the projectors was ripped out due to the "freezing" of a misfit shutter shaft. A telephone call revealed that to obtain the nearest replacement part would require an automobile trip of almost eight hours, or high-speed railroad shipment of six hours. The breakdown occurred at 5:30 P.M., and one projector continued the show. A collection of gears from obsolete miscellaneous projection equipment was assembled and taken to the machine shop. Two and a half hours later, after multiple grinding, brazing, turning, and boring operations, the disabled projector was again in service.

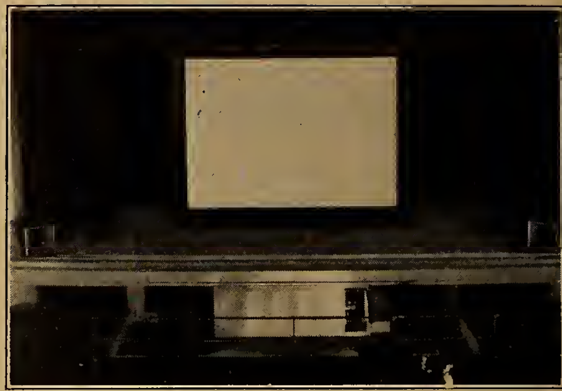


FIGURE 2
Screen and amplifier in local high-school auditorium, supervised by local projectionists

The replacement gear was so nearly identical to the original that the new gear, which arrived subsequently, has been held as a spare, and the emergency gear has never been removed. A point of interest is that the entire cost incident to rebuilding the gear was less than the factory cost of the new one.

Extensive Facilities Available

Almost every projectionist envisions a projection room where he can try out new ideas, uninterrupted by the routine of theatre operation. Twenty years ago our organization moved to make this dream a reality. Sponsored by the local high school principal and the student council, members of our group designed and supervised the construction of a modern projection room in the high school auditorium. Under the supervision of the author and Professors R. E. Offenhauer and H. W. Leach, visual instruction pioneers, this projection equipment has played an important part in the educational program of the high school system. The equipment and the auditorium have been available to our membership at any time. An elaborate physics and chemistry laboratory, and an industrial arts department, as well as a fair technical library, are also open to our members.

While the economic depression slowed up our activities, the interest of the student body has been responsible for the installation of a sound system which has been completed for use during the present year. This system was entirely constructed by projectionists and is one of the most elaborate in any school in the country. Fig. 1 shows the projectors and the photocell amplifier used in this installation. Voice reinforcement. radio and non-synchronous equipment are available. Hard-of-hearing aids are being installed for the benefit of those so afflicted.

Fig. 2 shows the auditorium stage with the microphones, speakers, and amplifier cabinet located in the orchestra pit. It would be almost impossible to list all the original ideas that have been developed in this projection room, and special work has been conducted in practically every branch of projection.

One of the most important benefits derived from our cooperative tie-up with the school system is that the students, and through them their parents, realize that our projectionists' organization is an important civic asset. Our members are welcomed as guest instructors in both

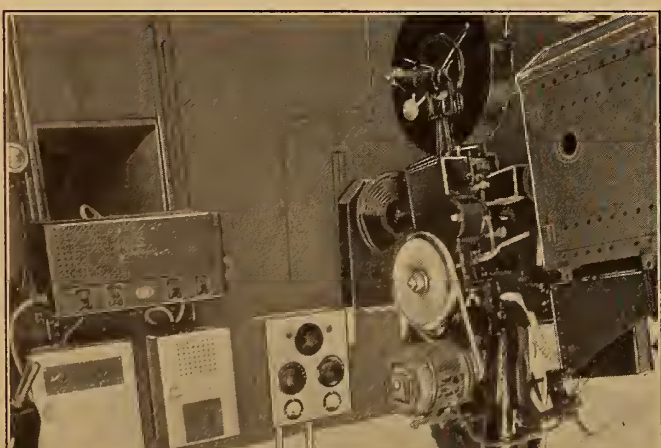


FIGURE 1
Experimental projection room outfitted and maintained by local projectionists

FIGURE 3
Demonstration equipment for lecture, "Giving the Movies Their Voice," which has met with great success

TABLE A. *Trouble Case Histories*

Case	Trouble	Off Screen	Nearest Service
1	Main drive gear stripped	8 min.	4 hours
2	Speaker field burned out	25 min.	None
3	Generator completely disabled	22 min.	10 hours
4	Motor control transformer burned out	2 min.	6 hours
5	Tubes in voltage amplifier burned out by current surge	100 min.	6 hours
6	Film damage due to worn parts	(Hopeless)	

the public and parochial schools. Their knowledge of the physical sciences permits them to aid the teachers in presenting practical experiments and demonstrations. This works a two-fold benefit, creating interest in our profession among students and teachers, and stimulating interest in modern education among our own members.

Service Sells Good Will

A contact committee carefully handles matters of publicity dealing with projection. This committee makes no attempt to promote either theatres or pictures, and never permits itself to be used for ballyhoo purposes. Its activities are apparently without end. Physicians and surgeons request their assistance in enlarging x-ray films and microscope slides by projection. A breakdown in the local broadcasting station brought a quick call for assistance. The police department has contacted us for the use of ultraviolet equipment, and a number of churches and schools keep 16-mm. film records of their most important activities. The camera work is always assigned to our members. We find that our offers of cooperation and assistance usually surprise our fellow townsmen. Too often the policy of exhibitors has been to contact fellow business men only when they have wanted something.

Recently a prominent industrialist suggested that there was probably considerable romance behind the scenes in projecting pictures, particularly since the subject has always been a closed book to the public. As a result of the idea we assembled and staged a series of demonstrations entitled "Giving the Movies a Voice." Fig. 3 shows some of the sound equipment used in this lecture. Originally intended for the benefit of one of our luncheon clubs, the demonstration has been given in three local high school auditoriums and before many service and luncheon clubs. Its popularity has brought many attempts to book the demonstration as a standard lyceum act. As a builder of good will, we consider it invaluable.

The main idea that we have attempted to carry out in our organization is to give 100 per cent projection service to the theatres and, by selling our organization to the city at large, to gain their cooperation wherever we may need it.

Our service activities do not represent a commercial or money-making project. We have no wish or intention to operate in competition to regularly organized service, supply, and repair agencies. Our activities are planned for the express purpose of keeping the picture on the screen as far as possible regardless of equipment and current supply failures, and to do so at reasonable cost.

The case histories in Table I are ample proof of the time saved by our emergency service system.

Our service facilities are not limited to this city alone, but are also available to projectionists in the many nearby small towns. However, managers in these towns who will not pay reasonable wages to their projectionists are politely informed that our assistance is limited to exhibitors who are willing to cooperate with their employees, and that a reasonable compensation to their projectionists is the surest indication of such a spirit of cooperation.

Discussion:

MR. EDWARDS: In speaking of managers who are generous enough to buy a spare tube and lock it in the safe, Mr. Hover assumes that that is small-town practice. We have theatres in New York in which six to eight carbons are taken out of the safe in the morning and handed to the projectionist, who has to make them do for the whole day or he is out of luck.

One of the points where we need cooperation most is between the managerial staffs and the projection rooms. The cooperation is generally all from the one side, especially as regards material. On several occasions I have tried to induce the Society, through the Projection Practice Committee, to try to do something about educating the managers, but to date we have not gone very far with it.

In the majority of theatres the manager has no technical interest in projection. He takes projection as a matter of course, just as we do when you press a button to light a room in the home. It does not occur that in pressing the button we utilize hundreds of different agencies to produce that light. All we think about is that we press a button and the room lights up. Managers very largely do the same thing; their chief interest is on the lobby and the house.

MR. HOVER: To work a plan such as ours, in a small town, we must have the cooperation of the exhibitor, if only to the extent of placing a few passes appropriately. Our system has not solved the service problem. All it has done is to increase the speed with which we can get the picture back on the screen in case of stoppage. Success has been largely due to the fact that, with one exception, and that an independent house, we have had wonderful cooperation from the managers.

It is only fair to say, however, that the sound and servicing system in most of our theatres is very good. It is a fact, of course, that a breakdown usually occurs when the service engineer is elsewhere—that seldom fails; but during a period of five years, the engineer has never been called into a theatre to find the picture off the screen. The show was always running long before he arrived.

Data on Academy Awards For Film Scientific or Technical Achievement During 1937

THE awards granted recently by the Academy of M. P. Arts & Sciences for scientific or technical achievement[1] during the year 1937 were predicted upon the highest total number of successful nominations since the inauguration of the award plan, thus providing a stimulus to the further progress of motion picture engineering in all branches of the industry.

A detailed statement anent the character of each achievement, as contained in the formal citations, is appended hereto:

AWARD IN CLASS I (Academy Statuette and Plaque): To Agfa Ansco Corp. for their Agfa supreme and Agfa ultra-speed pan motion picture negatives.

These two new panchromatic films provide a means of reducing working lens apertures, resulting in increased definition, and provide a tool to obtain, under adverse conditions, high-quality photographic results heretofore impossible. In addition, the use of this film increases the latitude, the realism, and scope of process projection work.

The development of these two films reverses what has long been considered an axiom by manufacturers and users of film stock, namely, that an increase in speed is always associated with increased grain size. These films retain to the full extent the qualities of panchromatic emulsions and at the same time provide a much higher speed while maintaining former grain quality. Thus, they increase photographic quality and tend to lower lighting costs.

The Disney Multi-Plane Camera

AWARDS IN CLASS II (Plaque): To Walt Disney, Ltd., for the design and appli-

(*Continued on page* 33)

[1] Highest non-technical awards were: Best picture, Warner Bros.' "Zola"; best performances, Luise Rainer in M-G-M's "The Good Earth," and Spencer Tracy in M-G-M's "Captains Courageous." Two other awards not mentioned elsewhere herein were to T. L. Moulton for sound recording on Samuel Goldwyn's "Hurricane," and to Carl Freund for cinematography on M-G-M's "The Good Earth."

Television and the Electron

By *VLADIMAR K. ZWORYKIN*
DIRECTOR, ELECTRONIC RESEARCH LAB., RCA MFG. CO., INC.

The fourth of a series of articles covering recent technical developments in television and charting the future of the art, presented herein through the courtesy of RCA Institutes Technical Press. Necessary improvement in viewing and reproducing units are cited, as well as other less well-known problems tending to delay the introduction of nation-wide network television programs.

IN THE latter part of 1936 the R.M.A. decided upon a set of standards to be applied to commercial television receivers. Among the requirements specified were those that the system should produce a 441-line picture with a picture frequency equivalent to 30 per second. These standards were accepted by the television engineering world with the utmost complacency.

If such a set of standards had been announced a few years ago it would have been instantly branded as quixotic idealism by almost every worker in the field. When it is realized that television research has been actively carried on for the past quarter of a century, this rapid advance in the last few years takes on real significance.

The cause of this extremely rapid advance which has changed television from a laboratory plaything into a practical engineering accomplishment was primarily a change from mechanical methods of picture transmission and reception to cathode-ray systems.

Cathode-Ray Television

Pioneering work in the field of cathode-ray television had been carried on by a few isolated workers for a numbers of years previous to its general recognition by the major research laboratories. The work of these men served to illustrate to the world that the basis of cathode-ray television was sound, and that electronic methods offered a solution to such problems as those of obtaining sufficient illumination on the viewing screen, of inertialess scanning required to obtain high definition, and sufficient sensitivity for the successful transmission of pictures under ordinary conditions of illumination.

Once the way had been pointed out, a number of the more farsighted television research laboratories initiated a program of intensive research along this line. This work has been going on for the past five years and has led not only to refining the basic principles advanced by the pioneers but also to the discovery and adaptation of a great number of new principles. As a consequence of this effort, both the television transmitter and receiver have become a practical reality.

The television receiver as it is today —using the Kinescope*—resembles, in appearance and size, a console radio receiver. The reproduced picture is sufficiently brilliant to watch without strain in a moderately lighted room and is in size about a page of this magazine. Thus, while such a reproducing device is a long way from ideal, it nevertheless is capable of bringing to the observer a picture that has high entertainment value, one which is both pleasing and informative.

Network Problem Difficult

The pickup camera employing the Iconoscope* is but little larger than a commercial 35 mm. moving picture camera, and since it contains no moving parts can easily be made portable. At its present stage of development its sensitivity is sufficient to enable the transmission of an outdoor scene under almost all conditions of lighting, or a studio picture when bright but not uncomfortable lighting is used.

The picture signal from this and accompanying sound pickup is carried to the main ultra-short wave transmitter through cable or radio relay, and from there it is transmitted on a carrier of 5- or 6-meter wavelength. Such a transmitter is capable of servicing a radius of from 30 to 50 miles, depending upon the topography of the terrain.

Of course, it must be recognized that the problems of covering the country with a network of television transmitters, of manufacturing a reasonably priced receiver, and those involved in organizing and producing suitable programs are enormous. These problems are ones that must and will be met by the manufacturer, the production engineer and the technician. This solution is only a matter of time.

Even if some inconceivable law should come into existence that prevented the application of any new principles or developments to the cathode-ray television system as it stands today, I am convinced that it still would become a commercial reality, that the system is amply capable of producing a picture which would satisfy a real economic demand.

However, this is equivalent to saying that the automobile of 1910 was a commercial reality. Certainly it was a mode of transportation which met a definite demand, and if all development had ceased at that date, the automobile still would be extensively used today. Just as the useful but crude vehicle of 1910 has evolved into the luxurious motor car of today, which in its turn will be supplanted by an even better vehicle in the future, so the application of the laboratory rsearch which is going on today must inevitably lead to improvements in the cathode-ray television system.

Viewing Tube Development

Of course, the statement that marked advances in cathode-ray television *can* be made is not proof that this progress is possible. However, research which is being carried out in the laboratory gives ample evidence of the improvements that may be expectd as our knowledge increases. To give a concrete example, recent advances in electron optics makes it possible to produce an electron copy of a visible image, and secondary emission, which has only recently begun to be seriously studied, makes it possible to intensify this copy. These two new principles have been applied to laboratory models of the Iconoscope with a consequent manifold increase in sensitivity.

Another example that might be cited is that of the viewing tube. The size of the present television picture is limited

(*Continued on page* 32)

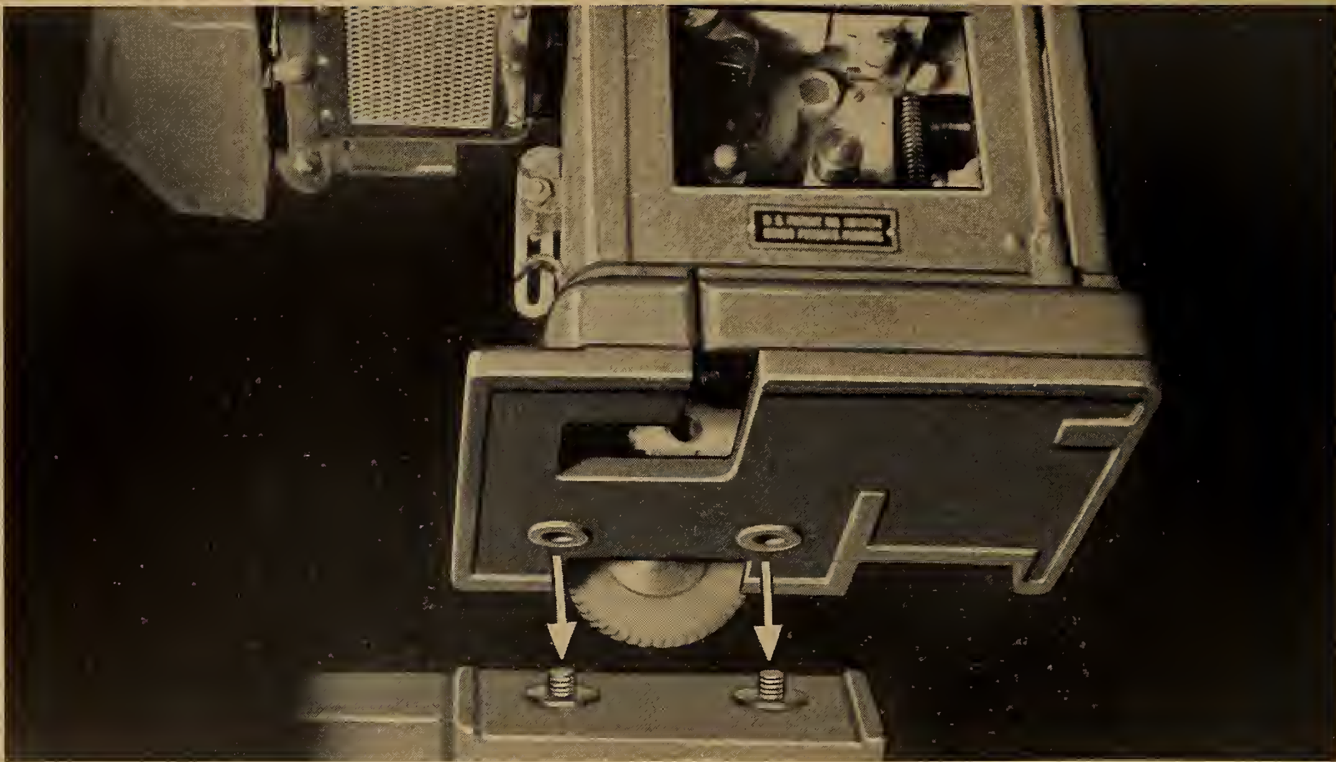
* Registered Trademark of RCA Mfg. Co., Inc.

2-Men Law Wins Locally, But Loses in N. Y. Legislature

LOCAL ordinance requiring two-men theatre projection room shifts adopted by the Newburgh, N. Y., Board of Aldermen was upheld by the N. Y. State Supreme Court in test case initiated by exhibitors who objected thereto on three grounds: (1) two-men shifts are unnecessary, (2) alleged coercion of aldermen by Union, and (3) aldermen lacked jurisdiction. No appeal is likely.

Significant was appearance of several local exhibitors on behalf of the ordinance. James J. Finn, editor of I. P., appeared for the Union on technical aspects of the case.

N. Y. State Legislature killed bill requiring two-men shifts in first-class cities (N. Y. City and Buffalo).



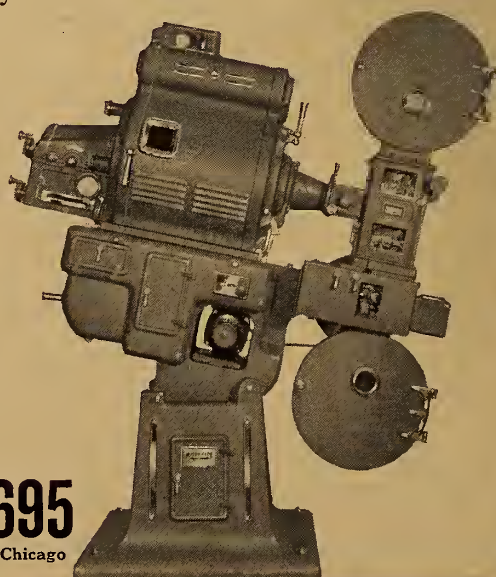
COMPLETELY INTERCHANGEABLE

The Motiograph Model "K" mechanism fits *any* standard base . . . . *any* standard sound reproducer, because the bolts which hold it in place are in the standard location. And because the hardened and ground, ball-bearing drive gear meshes perfectly with the driving gear of any standard sound reproducer. No expensive adaptation parts are needed.

This interchangeability feature is doubly important in theatres where a rebuilt mechanism is held in reserve for that unlikely emergency.

Don't overlook this important standardization fact if your theatre is joining the swing to Motiograph.

There are other features . . . . the ones which are found exclusively in Motiograph. Why not inspect them at close range in the showroom of the Motiograph dealer in your film trading center. See for yourself why this projector is "Standard Of The World".



THE NEW LOW PRICE PER PAIR COMPLETE $1695
Less Lamps and Sound Reproducers F.O.B. Chicago

MOTIOGRAPH, Inc., Chicago, U.S.A.

Analyses of Modern Theatre Sound Reproducing Units

By *AARON NADELL*

IV. Power Supply Circuits

ALTHOUGH performing no functions directly connected with sound reproduction, the power supply and conversion circuits which are part of every sound installation are as likely as any other part to occasion trouble. Complete sound outage, hum, foreign noise or sound distortion may have their origin in power circuits that are both physically and electrically remote from the actual voice equipment.

This fact complicates all trouble-shooting. Assuming that trouble has been traced with certainty to some amplifier, loudspeaker or other sound component, an intensive investigation of that apparently faulty component still is not in order. Instead, the next step is to find out whether that component or its power supply is the real cause of the difficulty; until this has been done internal trouble shooting still is a waste of time.

The power supply units, however, may be inside of and integral with the amplifier or other unit they supply. This physical identity has no electrical significance; the power circuits built into an amplifier, as in Fig. 1, are just as distinct from the amplifier electrically as if they were (like Fig 2), in an entirely separate cabinet which might be located at the remote end of the projection room or even in another room. Fig. 2, as a matter of fact, is a speaker field supply unit, which is commonly found not only in the generator room or in the old battery room (if there be one) but even backstage.

Complete sound outage may nevertheless be found due to failure in Fig. 2—for example, to outage of its fuses. In this case simple headphone tests will reveal sound going to the loudspeaker (or speakers) leaving only the question of whether the speaker voice line or power supply is at fault. The monitor field signal bulb (if their be one), or a voltmeter applied to the monitor field terminals, will remove this doubt and show definitely that the circuits of Fig. 2, wherever the actual cabinet may be located, need investigation. In some theatres the rest of the trouble hunt may have to be carried out from the top of a ladder propped against the backstage wall.

Again, foreign noises might arise from any intermittently open circuit in Fig. 2. or hum from open-circuiting of C-1 or; short-circuiting of L-1.

All of the above is equally true of the power pack which constitutes the lower right-hand corner of Fig. 1, and must be considered just as much an electrically independent unit as Fig. 2, although physically so built into and merged with the amplifier that, in practice, the distinction is not easy to draw.

Current Rectification

In dealing with troubles that arise or may arise from power supply circuits, it is helpful to remember that whatever its location, construction or nature, a power circuit performs only three functions, or less. These are:

1. To convert a.c. to d.c.
2. To remove the ripple from d.c., whatever its original source may be.
3. To change the voltage of the original power source.

All three of these functions are performed in Figs. 1 and 2; only two of them in Fig. 3, and only one in Fig. 4.

Conversion of a.c. to d.c., known as rectification, is done in the projection room by any one of 7 devices, which are: (*a*) the motor generator, or rotary converter; (*b*) the two-element vacuum tube; (*c*) the two-element gas tube; (*d*) the three-element vacuum tube; (*e*) the copper-oxide rectifier, or (*f*) the magnesium-sulphide rectifier.

(*a*). The rotary converter or motor generator are now substantially obsolete for sound purposes, and therefore deserve little space. Hence these two devices, although in some ways distinctly different from each other, are grouped here under one head. The output of these units is not pure d.c. but contains ripple which must be filtered. Rectifiers have displaced them for sound purposes, both because they cost less and because they need less attention in the way of cleaning and lubricating. They were widely used a few years ago, and theatres that have not yet modernized their equipment still have them. They may recreate hum in the sound when the output commutator becomes so dirty, or so pitted or worn, that the resulting ripple exceeds the capacity of the connected filter, or when the bearings become so worn that their rotation is unsteady. Complete sound outage seldom occurs,

You Can Test Your *Craftsmanship and Win Valuable Prizes in This Question and Answer Contest*

Appended to each article by Aaron Nadell are four questions for the best answers to which four awards are made each month. The Contest is open to any subscriber to I. P. who is engaged in practical projection work. Awards are made on one basis only—the best answers; manner of presentation counts for nothing. Also, the names of those whose answers average fifty per cent correct or better are published.

All answers must reach I. P. not later than the 1st of each month. The judges are Mr. Nadell and the editor of I. P. In case of a tie, identical awards are made: last month there were seven awards to contestants living as far apart as England and Wyoming; this month there are five winners.

The prizes awarded include valuable accessories useful on or off the job—witness the $15 electric shaver award this month. At the end of six months a grand prize will be awarded for the best single group of answers submitted during that period. Apart from the awards, the Contest is excellent practice and provides an excellent opportunity to test your knowledge of the art.

To date the questions have dealt mostly with theory; but the next issue will usher in a series of questions anent practical projection. Thus will the "practical" man who, shying from theory and "book-learning," be accorded his innings. Nothing should deter a potential contestant, and above all not the fear of netting a poor mark. If fellows from Lima, Ohio, from Norwich, Conn., from Rawlins, Wyo., and from Moscow, Idaho, can pitch strong enough to win, so can you. So get in there and pitch.—*Editor*.

unless the device has been so badly neglected that one of the coils is physically damaged.

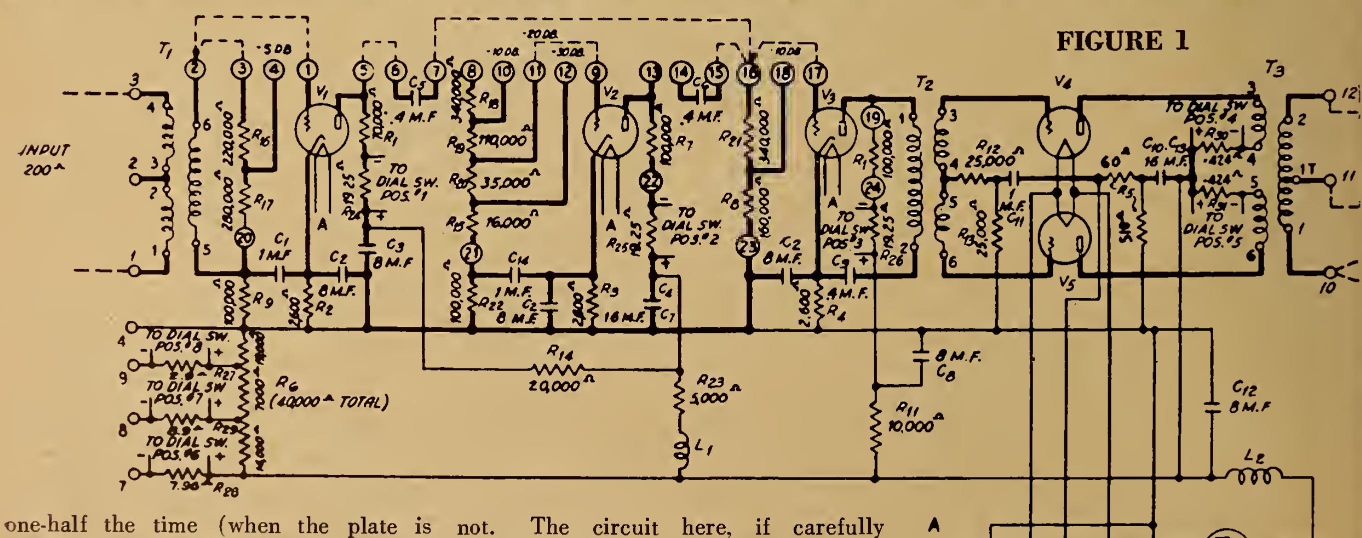
(*b*). The two-element vacuum tube forms the theoretical base for all tube rectifiers, although now tending to give way before the gas tube. It contains a filament, which emits electrons when heated, and at least one plate. An alternating potential is connected across plate and filament. When the polarity is such that the filament is positive with reference to the plate, the emitted electrons are attracted back to their source, and no current flows across the vacuum. When the polarity reverses and the plate becomes positive, the electrons are attracted to that element, closing the vacuum circuit and permitting current to flow.

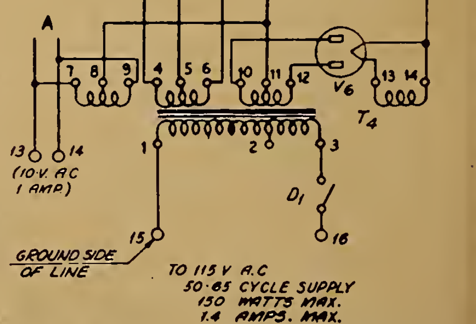
As a result of this automatic action within the tube, current can never flow more than one direction, despite the fact that the potential applied is alternating. Therefore the load can be, and is, connected directly in series with the a.c. source, and when so connected will carry only d.c.

Two-element rectifier construction is diagrammed in the tubes of Fig. 2. These tubes are not of the vacuum type, but are gas-filled.

A practical handicap in the way of using a two-element tube, as just described, is that the d.c. output flows only

FIGURE 1





one-half the time (when the plate is positive), hence is extremely unsteady. Extensive filtering is required to make its output practical for most sound purposes. Consequently the modification known as a "full-wave" circuit represents the most common application of this form of rectifier.

Fig. 2 represents a full-wave circuit using two tubes so connected that whenever the plate of one is negative the plate of the other is positive. The load (wired in series between the a.c. source and the filaments) therefore carries some current at all times, except at those moments when the polarity is passing through the zero stage in the course of reversing itself. This form of output, while also unsteady, is much less so than the output of a single tube, thus is far easier to filter.

The a.c. source in Fig. 2 is, of course, the plate secondary of the power transformer seen at the left. One side of that source is the center tap of this winding; the other side is whichever end of the same winding happens at the moment to be positive with reference to the center tap. The result of this arrangement is that the parallel connection between the filaments of the tubes is positive at all times, while by comparison the center tap of the secondary is always the d.c. negative. The d.c. load is connected across these two points; it is a double load, consisting of two circuits in parallel: one supplies the monitor speaker; the other from two to six screen speakers. Each circuit has its own filter consisting of a series inductance and a parallel condenser.

The interests of compactness and convenience are best served by combining the two tubes of Fig. 2 into a single tube, as in VT-6 of Fig. 1, which is also called a two-element tube despite the fact that it contains three elements, namely, a filament and *two* plates. Conventionally, the name "three-element tube" is reserved for devices that include a grid, which VT-6 of Fig. 1 does not. The circuit here, if carefully traced, will be found substantially identical with that of Fig. 2. It was analyzed in detail in I. P. for Dec., 1936; that of Fig. 2 in I. P. for Jan., 1936.

For present purposes it is enough to note that VT-6 in Fig. 1 would continue to function exactly as it now does if one of its two plates were open-circuited, *except* that the d.c. output would be cut in half, and filtering would have to be much more elaborate to keep out hum. The same applies to Fig. 2, if one of its two tubes were removed from the socket.

Considering these observations, it should be easy to see that the double diode of Fig. 1 offers a further advantage over the two-tube arrangement of Fig. 2. Suppose one of the two tubes in the latter illustration becomes weaker than the other. It is obvious that this approaches the condition in which one tube has been completely removed—namely, output will be reduced and hum will be increased. The greater the disparity in condition between the tubes, the greater the chance of hum, low volume, or both. Further, since these tubes are not normally worked at maximum capacity, the stronger of a pair will tend to compensate for the weakness of the other by carrying more current than it normally should. That tube's fuse (and its individual half of the power transformer, too) will be in some danger of burning out.

On the other hand, the double diode of Fig. 1, being a single unit, will tend to weaken equally with reference to both plates. It is therefore much less likely to cause hum or to stop a show, and there is no matching to be done. In the case of Fig. 2, the tubes should be matched by comparing their individual plate currents, and this check should be repeated frequently as a precaution against one-sided weakening.

In spite of these advantages in favor of the double diode, the arrangement of Fig. 2 is more common in theatre work than that of Fig. 1, for reasons that will soon become clear.

(*c*). As stated, the tubes in Fig. 2

are of the gas type—in this case the gas is argon. Mercury vapor is also widely used, causing a strong purplish glow, whereas the glow of argon, in the quantities involved, is so slight as to be almost invisible.

The gas increases the rectifying (current-carrying) capacity of a tube of given size by reducing the internal resistance; more explictly, by increasing the emission, for the resistance in a vacuum tube does not lie in the vacuum, which offers zero opposition to the passage of current. The emitted electrons themselves, however, tend to repel further emission, since all electrons are negative and like charges repulse each other. This repulsive effect is most important in the case of those emitted electrons located close to the filament, which thereby have the strongest influence in resisting further emission.

In the gas-filled tube, the gas molecules are broken apart into positive and negative ions by the impact of moving electrons. At times when the filament is negative (which is the only time emission matters in a rectifier) the positive ions are attracted toward the filament where they neutralize the repellant influence of the electrons in that vicinity and permit emission to increase. Consequently, a gas tube is able to do as much work as a vacuum tube several times its own size.

The ionization of the gas, and the resulting glow, are not created when the filament is turned on but the plate current left off, because under those circumstances the moving electrons do not have enough velocity to break up the gas molecules. It is only when the strong attraction of the plate charge speeds them up that they are able to strike a molecule with enough force to ionize it. (The relationship between the speed of an electron's motion and the attracting voltage that causes the motion is so close that electrons are often spoken of, as many projectionists have noticed, as having a *velocity* of so and so many *volts*).

FIGURE 2

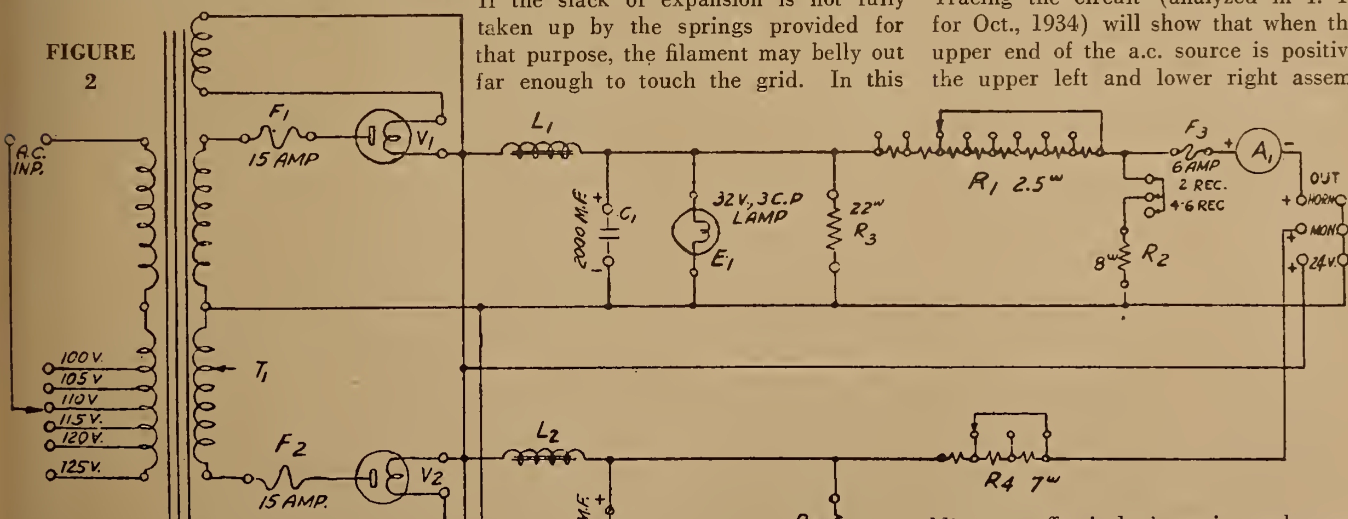
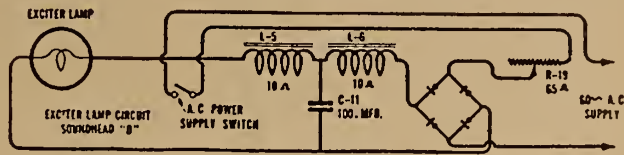


FIGURE 3



EXCITER LAMP SUPPLY

Despite the increase in current-carrying capacity that is obtained by filling a tube with gas, there still remains a limit to the amount of current a tube of given size can be made to carry, and this limit is the reason why all tube rectifiers are not double diodes as in Fig. 1. For heavy duty, even gas-filled tubes would become cumbersomely large, and also expensive. In the case of Fig. 2, where the wattage is relatively high, it is both convenient and economical to use two tubes and to change them one at a time as they grow weak.

(*d*). The true three-element tube—an amplifying tube equipped with a grid —is used as a rectifier in many sound systems, although not in any of the latest design. When it is so used, the grid is connected to the plate at the socket and becomes merely part of the plate. Electrically, the tube is then a two-element unit. However, since its physical characteristics, and particularly the close spacing between grid and filament, remain unchanged, this tube is somewhat subject to internal short-circuiting. The filament, expanding when heated, is attracted to the oppositely-charged grid. If the slack of expansion is not fully taken up by the springs provided for that purpose, the filament may belly out far enough to touch the grid. In this case, the fuses shown in Fig. 2 will open, or, if no fuses are provided, the power transformer will burn out.

(*e*). A copper-oxide rectifier circuit is diagrammed in Fig. 3. The arrowheads indicate the direction of flow of current through each of the four rectifying devices, the nature of the action of which is not clearly known.

The device itself consists of a copper washer which has been heated in air until the black copper-oxide forms on its surface. One surface is left coated; the oxide is ground away from the other. It is neither the copper nor the oxide, but the *junction* between the two that possesses the still rather mysterious property of conducting current in only one direction, and of offering high resistance in the other direction.

A number of these washers are strung on a threaded bolt, with lead washers between them to make better contact, and, sometimes, copper radiating fins to carry away the heat generated in their action. The assembly thus gathered around one bolt consists of a number of rectifying units in series. A nut taken up very tightly on the end of the bolt forces the lead, copper and oxide surfaces together for the best possible contact. For heavier currents larger washers may be used, or a number of the bolt assemblies described may be wired in parallel.

In Fig. 3 a bridge circuit is used to afford full-wave rectification, with exactly the same advantages as in the case of full-wave rectification with tubes. Tracing the circuit (analyzed in I. P. for Oct., 1934) will show that when the upper end of the a.c. source is positive the upper left and lower right assemblies are effectively in series and carry the current, the other two assemblies acting as resistances. The reverse condition occurs when the upper end of the a.c. source is negative.

The holding nut that clamps the washer assemblies on their bolt must be kept as tight as possible in a copper-oxide unit. If it loosens, the current-

carrying capacity will decline sharply.

(*f*). The copper-sulphide rectifier differs from the oxide unit chiefly in the materials used, and in the fact that it operates well at high temperatures; the oxide units must be kept cool by use of radiating fins, and (in large projection rectifiers) even by a fan. In the sulphide type, moreover, the holding bolt must *never* be tightened in the projection room, since not high pressure between the units but a very critical pressure is what is needed. In the factory, machinery is used to tighten these bolts correctly. Sulphide rectifiers are comparatively rare in sound work.

The magnesium sulphide rectifier is of the same general type as the two just mentioned, but is very seldom encountered in sound apparatus, although used to a considerable extent in projection units, where its stability in operation with large currents has been found advantageous.

Power Supply Filtering

All power supply filters used in theatre equipment are of the same general type and almost invariably consist of condensers and inductances. Each of the two output circuits of Fig. 2 contains a single inductance and a single condenser, the combination constituting one "stage" of filtering. Fig. 1 uses two stages, the first of which consists of L-2 and C-12, the second of L-1 and C-4, C-7. Fig. 3 has one "T" stage. Page 21 of I. P. for Nov., 1936, shows a variation of these circuits in which there apparently is no inductance at all, but actually the monitor speaker field coil serves as the choke, being excited itself by the same current which it filters for other uses.

Filters often include series or shunt resistance, as in Fig. 2, trouble in which may manifest itself as noise. If a shunt resistance should open-circuit, the filter output voltage will rise, increasing volume or causing distortion or both.

In Figs. 1 and 2 the power transformers change the 110-volt line supply

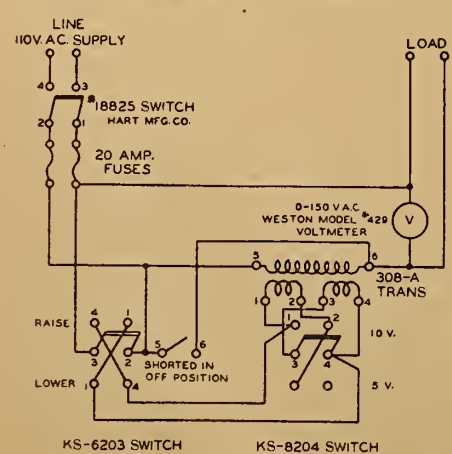


FIGURE 4

Here are the Contest Questions—

13. Where would you look for trouble if there were no sound, and a mercury vapor rectifying tube showed a lit filament but failed to show a blue glow?

14. What known electrical device could be used temporarily to keep the show going if the power transformer of Fig. 1 should burn out?

15. In an amplifier arrangement like that of Fig. 1, if the amplifying tube plates showed excessively red, with sound distortion at high volume, where in the power supply circuits would you look for the trouble?

16. What defects in a rectifier power supply can give rise to hum in the sound?

to meet the requirements of the rectifier. The rectifier filament windings are adapted to the filament voltages of the rectifying tubes, but the plate windings are designed for the voltage required by the output load, with due allowance for the loss in the rectifier and filter. The primaries of both transformers are tapped to adapt them to power line variations—between 100-125 volts in the case of Fig. 2.

Where the power line varies still more drastically (or where the sound apparatus is not equipped with the provisions just mentioned) special regulating devices are needed. One such is diagrammed in Fig. 4. The secondary of the transformer is the coil between terminals 5 and 6. A s.p.s.t. switch can be used to "short" this coil when the line input is normal.

The two coils of the primary of the transformer can be connected either in series or in parallel with each other, as desired, thus altering the voltage that will be generated in the secondary coil. If the s.p.s.t. switch is opened, restoring that coil to operation, voltage generated in it will be in series with the line voltage and will either aid or oppose the line, according to the position of the left-hand double-throw switch. The action is analyzed in greater detail in I. P. for May, 1935, p. 7.

A series resistor, or series rheostat, is also used for sound power control, particularly when loudspeaker fields are excited from the arc generator or arc supply rectifier.

Voltage Changers, Controls

Voltage changers and controls may occasion serious sound difficulties when they fail to function properly. When the failure is in the direction of lowered output, volume may be reduced, or distortion created through attempting to compensate for the trouble by increased amplification. When the voltage is too high, distortion may appear as a result of incorrect plate and grid bias in an amplifier, or, sometimes, rattling of a loudspeaker. High voltage may also cause a breakdown, directly or indirectly. The indirect effect is reached through such results of prolonged strain as the charring or baking of insulation, or the premature aging of tubes.

These Answers Copped the First Award

Something should be done about this Renfroe fellow, who cops first prize for the second consecutive time, but by only a whisker from Wilde in a ding-dong battle. The latter turned in a beautiful paper and would have licked Renfroe with a bit stronger finish. Two other repeat winners are Hover and Kenworthy. Only ten points apart were Renfroe and the No. 9 man, which bracket included the Messrs. Don Howard (a winner last month); Ray Mowery, Andrew Burtnett, and S. E. Moore; following which eight men tied at the next lower marking. That's competition!

Renfroe scored on one point that everyone else muffed (see note on No. 6); but several of the boys tripped Goliath on a minor point (see note on No. 7).—Editor

By *EVERETT M. RENFROE*

5. The plate current meter of a given tube reads high. The plate voltage and all other voltages of the tube are approximately normal. What is wrong? What should be done to correct the condition?

If ALL voltages are close enough to be correct for all practical purposes, the fault is either internal tube trouble or over-excitation. Gaseous tubes, caused by air seepage through the seal or envelope when extremely hot, or given up by the tube elements if heated very hot, will under some conditions cause high plate current. The tube must be replaced. A tube the elements of which are misplaced by mishandling, or even by internal expansion and contraction, may also give high current readings. Under these conditions, a tube must be replaced.

A tube working class A is worked on the straight portion of its E_g-I_p characteristic curve.[1] Under these conditions, whether passing a signal or not, the plate current

CONTEST WINNERS

(January Issue Questions)

First Award

EVERETT M. RENFROE

4633 So. Wabash Ave., Chicago, Ill.

Second Award

GEORGE WILDE

Columbia, Illinois

Third Award

THEODORE P. HOVER

Secretary, L. U. 349, Lima, Ohio

Fourth Award

The following tied for fourth place and will receive identical awards:

LEO CIMIKOSKI

184 W. Thames St., Norwich, Conn.

K. P. KENWORTHY

Kenworthy Theatre, Moscow, Idaho

is unvarying, the grid voltage always being negative. Now, if an exciting signal voltage is put on the grid and it has a peak value exceeding twice the fixed bias voltage, the grid will draw current and be positive on the positive half of the a.c. exciting voltage. The plate current will simultaneously increase on the peaks and follow the periodic swings.

If a steady tone is present, then, of course, the meter will stand still at a higher than normal I_p reading. A highly damped meter movement will read steady over quite a variation in current at audible frequencies. The cure is to reduce the exciting voltage to within the tube's proper range, or increase the bias voltage enough to permit the exciting voltage to be within the straight portion of the E_g-I_p curve when higher plate voltages are used. The plate voltage increase will be *mu* (amplification factor of tube)[2] times the increase in grid voltage (bias) in order to prevent distortion by plate rectification.

6. Dirt in a socket results in open contact at the grid of a Class A tube. What result can be expected? Will sound be lost?

What grid? What resistance does the dirt offer? What kind of tube—triode, pentode, or tetrode?

On grids where some current flows, such as screen-grid, a resistance of a few thousand ohms at most will effectively open the circuit. Opening of the screen or the suppressor grids will stop the tube from working, from all practical viewpoints, causing the plate current to drop to near zero or zero value. The control grid, however, does not draw current, so if the dirt's resistance of the dirt were even as high as five megohms, the tube would operate with but little loss in volume or quality, especially so if its internal construction puts it into the high *mu* class.

If of low *mu* characteristics, the resistance would be somewhat lower, say, up to about one megohm as a maximum. [Note: As long as the grid has its bias voltage, the grid itself can get its signal voltage by capacity effect between terminals, although separated.] The bigger and the closer together the contacts are, the lower the frequency that can be passed by the condenser formed. The loss of low tones will be more quickly noticed than the loss in volume, especially so if the resistance is not over a few hundred thousand ohms.

If the dirt made an open circuit sufficient to remove the bias, then low *mu* tubes would have great increase in plate current and no sound. The increased current may damage the tube, plate transformer primary (if used), plate resistors or cathode resistors—in fact, any part in the particular circuit unable to stand the overload may fail. In push-pull, sound would not be lost with high *mu* tubes but would be distorted with loss of low tones. With low *mu* tubes the effect would be one-half the primary of the output transformer "shorted." The overload may burn out the transformer, and the "short" would also become the load for the output signal. Depending on the resistance of the "short," there would be little, if any, sound available at the horns. Removing the tube relieves the "short," thus gaining sound with attenuated low tones. Replace only after contacts are cleaned.

[EDITOR'S NOTE: *This question was almost unanimously misunderstood, Mr. Renfroe alone submitting the correct answer. Every other reply was based on the assumption that an open circuit of this kind would have the same effect as an open switch, and completely insulate the grid in question. That isn't so, as anyone can find out by trying it. The only current that normally flows to a Class A grid is the displacement current—movement of just enough electrons to alter the grid charge, usually amounting to not more than a few millionths of an ampere under a pressure of one to several volts.*

The dirt that opens the contact doesn't have perfect resistance—there is some leakage through it. If its resistance were as high as a million ohms, which is very unlikely, one volt would still force through one microampere. The grid bias, which many assumed would be cut off, also comes through by leakage, since only a negligible flow of current is required to establish it, and once it is established no further current is necessary. The commonest result of this condition is a.c. hum, picked up by the high-impedance grid contact. In extreme cases, where the gain behind the open contact is very high, the amplifier may go into oscillation, and sound would be lost in that way.]

DESCRIPTION OF AWARDS TO CONTEST WINNERS

***First Award* (Renfroe): A Packard Lifetime Lektro-Shaver contained in a handsome leather carrying case.**

***Second Award* (Wilde): A Simplex volt-ohm meter of pocket size. Voltage ranges: 0-3, 0-30 and 0-300 d.c.; resistance range: 0-10,000 ohms. Magnetic vane type meter. Walnut bakelite case.**

***Third Award* (Hover): A copy of "Radio Physics Course," 2nd Edition, by Alfred A. Ghirardi. 972 pages. 6½ x 9, 510 illustrations, beautifully bound and completely indexed.**

***Fourth Award* (Cimikoski and Kenworthy): Each will receive a new type Radio Slide Rule for rapidly determining (1) capacitative reactance when capacity and frequency are known, (2) inductive reactance when inductance and frequency are known, and (3) resonant frequency when capacity and inductance are known.**

7. A short-circuit in or about a screen-grid resistor effectively connects the screen-grid with the plate. What will happen?

The load circuit—either resistance, impedance, or transformer—is "shorted," thus no "sound" output. The screen is closer to the cathode than the plate, so all the current attempts to flow from the screen grid

FIRST AWARD IS THIS FINE PACKARD ELECTRIC RAZOR

Rather than have Mr. Renfroe surfeited with technical appliances, this razor was sent to him for his winning answers. Smooth shaving!

---

[1] The chart commonly used to diagram a tube's performance: E_g is grid voltage; I_p is plate current. The characteristic curve shows graphically how plate current changes in response to alterations of grid voltage. Within certain limits of grid voltage, depending on tube design, the change is strictly proportionate and regular, and the curve is a straight line.

A Class A tube is given a fixed grid bias which normally centers its operation within the limits of this regular action. A Class B tube is permitted to work at or near one end of the straight portion of the curve, where a small change in grid voltage produces a disproportionately large alteration of plate current—a relationship represented in the graph by an abrupt curvature. In theatre amplifiers Class B operation is almost always at the lower end of the curve, with zero or nearly zero permanent grid bias.

[2] Mu (also written μ) represents the voltage amplification of a tube. If a change in grid voltage has the same effect on plate current that would result from a ten times greater change in plate voltage, the *mu* of the tube is 10. If the effect is the same that would result from a thousand-fold change in plate voltage, the mu of the tube is 1,000, *etc.*

instead of the plate. It will, in most cases, get red hot, make tube gaseous or even burn itself out if not turned off before long. In circuits using "resistance-capacity" filter networks there may be enough resistance in the circuit to keep the current below the value that would destroy the tube or release gas, but there would be no sound. In some cases the condensers by-passing the screen may "short out" under the higher voltage from the plate. If the lower voltage of the screen comes from the voltage divider on the power supply, then the "short" between screen grid and plate would lower the value of the bleeder resistance, thus increasing the load on the rectifier tube, maybe overloading it or the power transformer or chokes, or all these units.

[Editor's Note: *In many circuits sound will not be entirely lost if screen grid and plate are "shorted," but the tube will act as a triode, delivering sound at reduced volume. Several of the other contestants correctly stated this fact.*]

8. An internal tube defect short-circuits the filament to the control grid. What will happen in Class A amplification? In Class B? In Class AB?

This could hardly happen in an indirectly-heated tube, but in directly-heated tubes (filament-type as differentiated from cathode over filament, independent electrically) this would "short" the input signal and in Class A remove the bias voltage. If bias were from a separate source, a battery or rectifier, it would be "shorted" and thus damaged.

Now, the tube with grid and filament "shorted" could have a great increase in plate current, possibly sufficient to do damage to the output circuit—such as transformer primary, plate reactance or plate resistor, cathode resistor or/and cathode bypass condenser, if this method of establishing "C" bias is used. Also, there would be no intended sound; but if this happened in an early stage of an amplifier, there would be a 120-cycle noise which would be the amplified ripple in the plate current and would endure until something failed.

In a Class B circuit, two tubes are used at audio frequency. (Do not confuse with Class B at radio frequency, which does not need tubes in push-pull). These tubes are in push-pull and are of either zero-bias construction or biased to the plate current cut-off, or nearly so. A "short" between control grid and filament would do just as mentioned above for tubes in Class A, if the tubes used were regular Class A tubes biased for Class B operation.

Now tubes made especially for Class B, known as "zero bias" tubes, have no external grid bias, so no plate current flows unless a signal is present to swing the grid more or less positive. Such a "short," then, would not increase plate current, causing the associated damages; however, the "short" would be reflected into the driver tube circuit through the primary.

The "short" would take most all the input signal voltage, so since Class B is usually the last stage, there would be very little amplification of the balance of the signal in the other half of the primary, thus for practical purposes the sound would be lost. The reflected "short" would not damage the transformer, since the driver works Class A and the resulting effect would be the driver tube working into a mismatched load; so, since the a.c. generated signal could not be carried off, the tube temperature would rise slightly. No damage would ensue because in Class "A" the plate can dissipate the full load of the tube.

In AB classes the tubes have Class A characteristics until the driving signal exceeds the fixed bias: then the Class B action takes place. Thus a grid filament "short" would do everything as under the Class A description given above, except that since the output transformer is able to work under Class B ratings, the circuit would necessarily be left on longer before a burn-out of the transformer would occur, as compared with Class A. In cheap construction, however, it would not stand the abuse of a full Class B unit.

Highly creditable papers were submitted by the following, the appended listing of whom is not indicative of their ranking:

Don E. Howard, Rawlins, Wyo.; Ray Mowery, Mahanoy City, Penna.; Andrew Burtnett, Hannibal, Mo.; S. E. Moore, Lancaster, Penna.; Lawrence G. Borgeson, Los Angeles; T. Morisawa, Los Angeles; H. D. Taylor, Raleigh, N. C.; Lester W. Shaffer, Shrewsbury, Penna.; Raymond Bartzen, Sheboygan, Wis.; J. T. Kirkham, Calgary, Can.

Also, Roy B. Beal, Ft. Wayne, Ind.; Harold LeRoy, Cortland, N. Y.; Gerald H. Payne, Westerly, R. I.; W. Fenwick, Victoria, Can.; O. G. Taylor, Jacksonville, Fla.; Chester A. Ellison, Reading, Mass.; Carl Rossi, Brooklyn, N. Y.; Walter Fink, Mahanoy City, Penna.; E. L. Saunders, Newport News, Va.; Frank Swalbert, Buffalo, N. Y.

Also, Walter R. Pyle, Assiniboia, Can.; Roy J. Arnston, Minneapolis, Minn.; C. D. Chandler, Atlanta, Ga.; Clyde G. Richards, Corvallis, Ore.; Andrew R. Pura, St. Thomas, Can.; Anthony J. Ventimiglia, Cortland, N. Y.; Wm. R. McDonnell, St. Louis, Mo.; Haynes Howell, Roswell, N. Mex.; R. A. Young, Homestead, Fla.; Joseph P. Thomas, Elmwood, Ill.; and John L. Stauffer, Steubenville, Ohio.

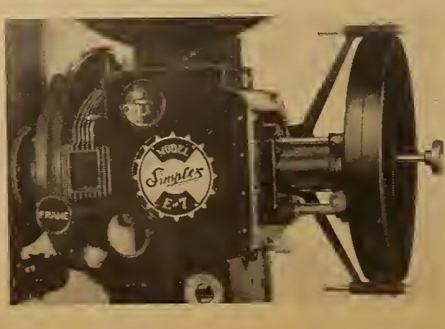
Setting and Operation of the Simplex E-7 Shutter

The double- or twin-shutter system employed by the new Simplex E-7 projector has been the topic of much discussion wherever projectionists get together, and I. P. has received many requests for more specific data anent this unit than was given in the brief caption accompanying the E-7 layout in last month's issue.

What seems to puzzle the boys is how two shutters turning in the same direction on a single shaft can give project more light onto the screen and still insure an absolute cut-off during the movement of the intermittent. The salient fact to be remembered in this connection, and one that frequently is lost sight of, is that the projection lens is located between the two shutters. What does this mean?

It means that utilization is made of a well-known but often overlooked function or property of optical lenses—the inverting of the image—and it also permits the use of a much narrower cut-off blade, which in the case of the E-7 shutter means a reduction from the usual figure of 90 degrees to about 72 degrees, without danger of travel-ghost. Thus, there is realized a net gain in light output of about $12\frac{1}{2}$ per cent.

The picture at the aperture is upside down. As the intermittent starts the rear shutter cut-off blade cuts off the top half of the picture on the screen, while the front shutter cuts the bottom half. The reversal of the picture in passing through the optical system making this possible. Thus, the picture is changed with a dissolving action from the center of the screen—a desirable condition.



If the shutters were both back of, or in front of, the lens, they would have to revolve in *opposite* directions to gain this effect; whereas in the E-7 it is accomplished with one shaft and without any additional gears.

More light is also obtainable with this shutter because of the reduction in width of the flicker and cover blades of the shutters, made possible by the use of disc shutters of large diameter, which means a greater peripheral speed, covering and exposing the picture faster and thereby permitting more screen light.

Setting the shutters is not difficult. A three-piece tool consisting of a barrel, a rod which has a flat face cut on each end, and a clip lever is furnished. To set the shutters: remove the lens and place the barrel in the lens holder. Loosen the screws on the shutter knobs (which are now *outside* the guard). Remove the aperture and insert the rod through the barrel, lifting the fire shutter, and push the rod (flat face down) until the end comes through the shutter. Now clip the lever on the end of the intermittent shaft with the sprocket in the stop position.

Turn the shutter shaft by hand until the lever shows that the sprocket is at the starting point. Move the cut-off blade of the shutter UP until it bears evenly on the flat face of the rod. Tighten the set screws on the shutter, and then going to the front shutter, follow the same procedure. Tighten shutter screws firmly. Now remove the rod, barrel and clip—and the job is complete.

It's a good idea not to forget to replace the lens and aperture plate. It has been done. Turning the shutter shaft by the knob in front means that the intermittent sprocket and the shutters move at the same time.

Chaotic Status of Laws Anent Projection Technic, Equipment, Rooms Revealed by Nation-Wide Survey

COMPILED BY BUREAU OF LABOR STATISTICS, U. S. DEPARTMENT OF LABOR

Piercing the maze of indifference, indolence and ignorance which has long enveloped those charged with the establishment and maintenance of regulations relative to motion picture projection, the U. S. Department of Labor has finally accomplished a job that no other agency, public or private, has been able to do—ascertaining what's what, how and why with respect to the final delivery of the motion picture to the public.

The fruits of this labor are presented here, and the record is a tribute to the ability, industry and perserverance of the Bureau. No matter that the results are not complete (that would be asking the impossible); the data obtained serves admirably to indicate the almost incredible chaos existing among motion picture regulatory bodies.

But that is another story for another day, a story that, by all that's holy, will be written. It will suffice for the nonce to read this compilation and to wonder at yet another manifestation of the unbelievable stupidity of those individuals and agencies whose job it is to regulate the exhibition of motion pictures.—*Editor.*

EVERY motion picture theatre must employ at least one projectionist to care for and operate the projection equipment. The room in which the projection equipment is placed is usually in an elevated position at the back of the theatre. This room is ordinarily small, and as the handling of motion picture film involves serious hazards from explosives and fumes, the safety of the operator and of the audience requires that the projection room be made as accident-proof as possible.

Because of the known hazards, safety precautions in the construction and maintenance of projection rooms are required, in most communities, by public regulation either in the form of State legislation, municipal regulations, or both. Much progress has been made in this direction in recent years, but there is still a surprising lack of adequate regulation in certain cities and areas. In general, it may be said that, where State legislation exists, the safety requirements are usually higher than where there are city regulations only; and also that city regulation through the building codes is more successful in guarding the safety of projection room workers than is regulation dealing solely with projection room safeguards.

In the final analysis, protection is afforded projectionists largely through carefully planned and executed construction, and the extent to which such sound construction is utilized—that is, by the installation of proper ventilation, safety devices and fireproof furnishings—depends, in large degree, upon the individual employer, the employer-employee relationship, local custom, and civic pride.

The Bureau of Labor Statistics has recently completed an analysis of State laws and city codes, ordinances, and regulations affecting motion picture theatres in cities which had a population of 50,000 or more at the time of the 1930 census. The present article brings together the provisions of these laws and regulations insofar as they relate directly to projection rooms. Detailed data by individual cities are available in the files of the Bureau.

The material in this article covers regulations in 186 of the 191 cities of 50,000 population and over. Of the 5 cities not covered, 1[1] reported no laws, and for 4[2] either the facts were not obtained or were too meager to permit inclusion here. Although it is believed that this survey gives a fair picture of existing laws and regulations, two qualifications should be noted: (1) The information was collected almost entirely by mail, a method which is never quite so satisfactory as that of personal visit; and (2) information was solicited only as regards those sections of the laws and municipal ordinances which dealt directly with motion-picture theatres. It is possible that in some cases, legal provisions not specifically referring to motion picture theatres, such as certain sections of a general labor law, may have a bearing on the safety of theatre employees.

Some Hazards Involved

Motion picture film, being of material which is highly inflammable and subject to deterioration unless atmospheric conditions are controlled, requires careful handling. In addition to the fire hazards resulting from the showing and handling of the film, employees engaged in projection rooms risk occupational disability through exposure to ultraviolet and infra-red rays[3] and to fumes given off when the film is exposed to the heat from arc lights.[4] In part the dangers in motion-picture-machine operation may be avoided by adequate ventilation.

The State of Nebraska in 1935 made an investigation of poisoning resulting from fumes, although no special correctional legislation has yet been enacted there. That study, carried on by the Department of Health, disclosed a number of cases of chronic illness among projectionists who use the carbon arc light. Some of these cases had been tentatively diagnosed as carbon-monoxide poisoning, but laboratory tests showed that the poisonous fumes were in fact nitric oxides. Knowledge of the oxides thus generated is not new, but the experiments reveal the importance of adequate projection-room ventilation to prevent disability from exposure of workers to fumes from arc lamps.

Projection Room Construction

The following discussion of physical requirements established for the construction and maintenance of projection rooms shows the extent to which the states in which the larger cities are located and the cities themselves have legislated to secure standards. Insofar as practical, the discussion is supplemented by tables showing the number of cities establishing given requirements.

Minimum requirements regarding floor area and height of projection rooms are established by public regulation, either State or municipal, in the majority of cities of over 50,000 population. It is also customary to establish standards for door openings in one or more of the following particulars: Size, construction, material, method of opening, or automatic features. Less common are requirements as to the area or dimen-

[1] Huntington, W. Va.

[2] Pueblo, Colo.; Jacksonville, Fla.; Springfield, Ohio; and Kenosha, Wis.

[3] Bureau of Labor Statistics Bull. No. 582: Occupation Hazards and Diagnostic Signs, p. 24.

[4] Letter dated Oct. 1, 1935, addressed to V. B. Kinney, Labor Commissioner, State Capitol, Lincoln, Nebr., by L. O. Vose, Director of Laboratory, Department of Health, Lincoln, Nebr.

Table 1.—*Classification of Cities by Requirements as to Projection-Room Size*

[UBC=Uniform Building Code; NBFU=National Board of Fire Underwriters; TIC=Travelers Insurance Company]

Minimum requirement	Number of cities
Total number of cities covered	186
Floor area (basis, 1 machine):	
100 square feet	1
80 square feet	1
60 square feet	2
50 square feet (UBC)	30
48 square feet (NBFU and TIC)	46
8 x 10 feet	2
9 x 9 feet	1
8 x 9 feet	6
8 x 8 feet	2
7½ x 10 feet	1
7 x 9 feet, 10 inches	1
7 x 9 feet	1
6 x 8 feet	20
6 x 7 feet	5
6 x 6 feet	4
6 x 5 feet	7
Floor area (basis, 1 machine)—Continued.	
25 square feet	2
5 x 5 feet	2
4 feet rear, 3 feet sides	1
3½ feet rear and sides	14
2½ feet rear, 3 feet sides	2
2 feet sides and rear	8
Sufficient to permit operator free movement	14
No provision	13
Height of room:	
9 feet	1
8 feet, 6 inches	3
8 feet	47
7 feet, 6 inches	1
7 feet (NBFU, TIC, and UBC)	103
6 feet	16
5 feet, 6 inches	1
No provision	14

sions of openings for projection of films and lookout or observation ports. Installation of sanitary facilities directly connected with the room for the use of projectionists is required in only one-third of the 186 reporting cities.

Room area.—Table 1 shows the classification of the cities by requirements as to floor area and height minima of projection rooms. The floor dimensions are for the first machine in a room.

In this and the other tabulations a notation has been made in every case where a particular standard has been set up by agencies concerned with making or proposing safety standards, such as the National Board of Fire Underwriters, National Electric Code, the Pacific Coast Uniform Building Code, and the Travelers Insurance Co. In order to conserve space, initials, instead of the full name of the body referred to, have been used.

The regulations of 114 cities require that the minimum floor area for the first machine in a room shall be 48 square feet or over. This group includes cities in which the minimum area is specified in square feet and also those in which the dimensions are given in linear feet, as 6 by 8 feet (48 square feet). These regulations conform with the standard (48 square feet) adopted by the Underwriters[5] and the T. I. C.[6]

The U. B. C.[7], adopted by 159 cities in 19 States and Hawaii, provides for a slightly larger floor area—50 square feet. Of the 30 cities of 50,000 and over prescribing 50 square feet, 16 are subscribers to the U. B. C., the remaining subscriber (Austin, Tex.) having adopted a higher standard locally. The representation of the Uniform Building Code cities in this study is low (17 cities), as many of the member municipalities are located in Calif. and are below the population limit to which this investigation was restricted. Standards in excess of 50 square feet apply in 18 cities.

A lower requirement than 48 square feet exists in 20 cities; in 14 cities it is required simply that the operator shall have free movement; and in 25, where it is required that there shall be a given number of feet at the rear and sides of the machine, it is not possible to state whether the net result is a smaller or larger work space than in the cities subject to specific requirements. Thirteen cities, as far as could be ascertained, had no minimum requirements regarding floor area.

The requirement as to floor area of projection rooms is written into a number of municipal ordinances and local building codes. The greater part of the higher requirements, however, originates in State law, as in Conn., Ind., Mass., N. J., N. Y., Tenn., and Texas. Ohio requires a floor area of 5 by 6 feet; in Penn. the distance between machines and walls is specified; and in Mich. the provision is of a general nature, namely, that operators shall have sufficient room to move about freely.

The standards proposed by the N. B. of E. U. and the T. I. C.—a floor area of 48 square feet for the first machine and 24 square feet additional for each additional installation—is generally in force in the large group of cities conforming to the 48-square-feet minimum for the first machine. In other areas, the additional space requirement varies considerably but tends to be lower, with the exception of the cities subscribing to the U. B. C., where theatres must provide 50 square feet for each machine, a considerably higher standard than that in force in other cities.

Height requirements of from 7 to 9 feet in 155 cities make adequate provision for the comfort of operators. In the 17 cities where the lower limit is 6′ and less, some inconvenience must necessarily be experienced by men of greater

Table 2.—*Classification of Cities by Requirements as to Projection-Room Doors and Other Openings*

[UBC=Uniform Building Code; TIC=Travelers Insurance Co.; NBFU=National Board of Fire Underwriters]

Requirement	Number of cities
Total number of cities covered	186
Door-opening specifications:	
Automatic closing, opening outward, fireproof, etc. (UBC)	66
Size of door:	
3 to 5 feet x 5 feet, 10 inches	2
3 x 7 feet	3
2 feet, 8 inches x 7 feet	5
2 x 7 feet	2
2 feet, 6 inches x 6 feet, 8 inches	2
2 feet, 6 inches x 6 feet, 6 inches	2
2 feet, 6 inches x 6 feet, 6 inches, 2 exits	1
2 feet, 4 inches x 6 feet	1
2 feet x 6 feet, 6 inches	3
2 x 6 feet, 2 exits	1
2 x 6 feet (TIC)	45
2 feet x 5 feet, 10 inches	13
2 feet x 5 feet, 6 inches	2
2 x 5 feet (NBFU)	22
No provision	16
Lookout ports—dimensions or area:	
2 square feet	1
150 square inches (UBC)	18
144 square inches	2
120 square inches	1
80 square inches	5
48 square inches	1
25 square inches	1
12 x 36 inches	1
12 x 24 inches	1
10 x 20 inches (NBFU)	8
12 x 16 inches	1
12 x 14 inches	6
12 x 12 inches	28
10 x 12 inches	1
8 x 14 inches	1
Lookout ports—dimensions or area—Con.	
10 x 10 inches	6
8 x 12 inches	3
6 x 12 inches	21
4 x 12 inches	16
2 to 8 inches	1
No larger than necessary	22
Opening required	14
No provision	27
Openings for projection—Specifications:	
Area:	
144 square inches	2
120 square inches (UBC)	18
80 square inches	5
48 square inches	1
64 square inches	1
25 square inches	1
2 square feet	1
Dimensions:	
12 x 36 inches	1
12 x 16 inches	1
12 x 14 inches	3
12 x 12 inches	22
8 x 24 inches	3
8 x 21 inches	1
8 x 12 inches	1
8 x 10 inches	1
8 x 8 inches	7
8 inches greatest dimension (NBFU)	0
6 x 12 inches	36
6 x 8 inches	9
6 x 6 inches	3
6 inches long	1
Opening required	14
No larger than necessary	26
No provision	28

[5] National Board of Fire Underwriters Regulations for Nitrocellulose Motion-Picture Film as recommended by the National Fire Prevention Association, effective Aug. 15, 1931. New York, 1931.

[6] Safety in moving-picture theatres. Hartford, 1914.

[7] Pacific Coast Building Officials Conference. Uniform Building Code, 1937 ed. Los Angeles, 1937.

than average height. The number of cities having no requirements (14) is nearly the same as the number having no provisions regarding floor area (13). In other words, localities (Ga. and Ill.) that do not regulate on one of these points tend to follow the same procedure on the other. In addition to the advantages of greater ceiling heights in making movement easier for the operator, ventilation is facilitated.

Openings.—Regulation of the kind and size of openings in projection rooms is intended to secure convenience and safety to the operators and a measure of protection to the public. Standards have been established for doors, lookout ports for the use of projectionists, and openings for the projection of films. In isolated instances (Syracuse, N. Y., and Cincinnati, O.) an emergency exit in the room is required in addition to the regular doorway. Table 2 classifies the cities by requirements governing the several types of projection-room openings.

Room Entrance Requisites

In a large proportion of cities (66) the question of projection room doors has been disposed of by requiring that protection be afforded through one or more of the following measures: Automatic closing, doors opening outward, and fireproof doors (in some cases these must be of a specified approved type). In almost an equally large group of cities (65) it is required that doors be 6′ high or over and between 2 and 3 feet wide. The regulations in 15 additional cities require doors to be at least 5′ 10″ high, while in 2 cities the minimum height is fixed at 5′ 6″ and in another substantial group (22) at 5′. The cities that reported no requirement on this point total only 16.

As will be seen in the table, the standards proposed by interested bodies vary widely as regards door size. The U. B. C. cities, in common with many nonmember cities, do not set a standard in this matter; while the T. I. C. favors an opening 2 by 6 feet, and the underwriters consider adequate a door 2 by 5 feet. Conn. prescribes an opening 2 feet 8 inches by 7 feet; in Mass., N. J., and Ohio statutes, and in some city legislation, the requirement is for a door 2 by 6 feet. Doors 2 by 5 feet are required in Kan., Tenn., and Tex. Mich. and Penn. require automatic closing.

Lookout ports for operators, and openings for film projection are subjected to regulation in about 85 per cent of the cities studied. The size required tends to be fairly uniform, with a slightly larger opening for the lookout ports, in order to give the operator easier and greater range of vision. Stress is placed on keeping openings as small as possible by general provisions (in 22 cities for lookouts and in 26 for projection) that they shall not be larger than necessary. The protection of these openings with automatic shutters when not in use and when a mishap occurs is made a special requirement.

The U. B. C. allows a 30-square-inch difference in size of the two openings—that is, 150 square inches for the projectionist and 120 square inches for the machine. Mass. law prescribes an opening 6 by 12 inches (72 square inches) for both. In Ind. the figures are 12 by 12 inches (144 square inches) for the projectionist and 6 by 8 inches (48 square inches) for the machine. In Conn. the machine opening may not be larger than necessary and the lookout is limited to 10 inches in its greatest dimension.

Sanitary facilities.—Of the 186 cities covered in this survey, almost one-third (58) require the installation of sanitary facilities in connection with the projection room, for the use of the projectionist. The building code of Columbia, S. C., states that such facilities are required unless a relief projectionist is on duty at all times, and the Wisc. law, affecting three of the cities here covered, prescribes such equipment where operation is continuous, unless 10-minute intermissions are provided after 2 hours of operation. The matter of sanitary provisions is governed by State laws in Calif., Conn., Penn., and Wisc.

Projection Room Ventilation

Under ideal conditions, ventilation of projection rooms is effected by a system through which air enters slightly above the floor level on all four sides of the room and is carried off by a ceiling opening vented to the outer air, if pos-

Notes From the Supply and Service Fields

BOTH major servicing organizations have been increasingly active of late. Altec announced the closing of service contracts for all the 20th Century-Fox exchanges in the U. S., including parts; with the Golden States Theatres for 75 houses through California; with the Griffith interests in Texas, and with the 20 Essaness theatres in Chicago. An Altec warehouse has been opened in Los Angeles.

RCA closed servicing deals with 21 Wilmer & Vincent houses; with the Fabian Circuit for 23 houses in New Jersey, and with 65 Saenger Circuit houses in Southern states.

MOTIOGRAPH'S NEW LIST PRICES, SOUND MODERNIZATION PLAN

Motiograph, Inc., made several important announcements during the month. The new list price on a pair of Motiograph K projectors complete with magazines and bases is $1.695, reflecting a downward modification of $775. This new price, Motiograph stated, meant that the same quality of design and manufacture would be maintained, the move being directed at the "elimination of fictitious list prices and vague, elastic discounts."

Motiograph is now offering a complete line of modernizations for late-type sound systems of W. E. manufacture, to be sold through the former's national dealer setup. This marks no departure from Motiograph's refusal to sell component parts of its sound system, modernization being available only on four engineering options, depending upon the type, age and condition of a theatre's equipment.

H. B. (Tex) Rickards has joined Motiograph as director of advertising and publicity. He has had a long and varied career in the newspaper, motion picture, radio and sales promotion fields.

FOREST FILLS NAVY ORDER

Forest Mfg. Corp. has just completed delivery of a large group of special power rectifiers to the U. S. Navy. The units passed all tests satisfactorily.

SORENSON'S TEXAS SUPPLY CO.

Henry Sorenson, formerly of the Texas Theatre Supply Co. in Dallas, has formed the Modern Theatre Equipment Co. at 2009½ Jackson St., Dallas, to distribute, among other items, Motiograph projectors and sound equipment, Brenkert lamps and Da-Lite screens.

BOOTH B. & H. SALES MANAGER

J. Harold Booth has been named General Sales Manager for Bell & Howell Co. of Chicago, succeeding J. G. Llewellyn, resigned. Booth moved up from Assistant Sales Manager, and was formerly development engineer in the B. & H. research laboratories, specializing in the design of amplifiers and sound projectors.

RADIANT LAMP CATALOGUE

A new catalogue of incandescent projection lamps is available from Radiant Lamp Corp., 25 Lexington St., Newark, N. J. The list applies to 8-, 16- and 35-mm. projectors. Radiant has just enlarged its plant, and is now appointing additional distributors and jobbers throughout the world.

G. T. E. SHOWS MILLION PROFIT

Net profit of General Theatres Equipment Corp. and subsidiaries for year ended December 31, 1937, was $1,199,-415 after depreciation, federal taxes and other deductions, according to organization's report just issued. In preceding year company reported net profit of $959,509 for period June 1, 1936, beginning of business, to Dec. 31, 1936.

sible, and to a flue system as an alternative. The movement of air is facilitated by the use of fans. Only in exceptional cases is the minimum rate of air change that is acceptable in a room made a part of State or municipal regulations. In some of the more up-to-date theatres with air-cooling systems, projection room ventilation exceeds the minimum public requirements. A typical section on this phase of safety and health protection, taken from the Ind. laws and regulations for opera houses, theatres, motion picture shows, auditoriums, and other places of amusement,[8] reads:

> There shall be an opening on each of the two sides and in the rear wall of the booth, not higher than 3 inches above the floor level. Each opening shall be 15 inches long and 3 inches high. Said inlet shall be covered on the outside by a wire netting of not greater than 1/8 inch mesh. There shall be an opening in or near the center of the ceiling of the booth not less than 10 inches in diameter to be provided with an iron flange, which flange is to be securely fastened. To this flange shall be attached a metallic vent pipe of not less than 10 inches in diameter, said pipe leading to the outside of the building or to a special incombustible vent flue; all parts of vent pipe to be at least 6 inches from any combustible material. If it is impossible for the said vent pipe to rise vertically from the booth to the outside of the building, a forced-draft system must be employed. All arc-lamp housings must be connected to the booth ventilating system.

Intake.—The classification of the cities covered according to regulations as to the number and size of wall inlets for ventilation is shown in Table 3.

A provision for 3 inlets in a projection room is included in the State or city regulations covering 51 cities. In addition, 4 such inlets are required in 17 cities, 2 in 6 cities, and 1 in 24 cities. In 2 cities the requirement is for openings on separate sides and in 2 more, for one opening for each machine. The 14 cities where openings are required but the number is not stated include Penn. cities in this survey that do not have higher local standards on this point and operate under State law. The U. B. C. requires openings on 3 sides. In total the cities with requirements as to number of wall inlets represent about 62 per cent of the reporting number, while in the remaining 38 per cent (70 cities)

TABLE 3.—*Classification of Cities by Requirements as to Number and Size of Ventilation Inlets of Projection Rooms*

[UBC=Uniform Building Code]

Requirement	Number of cities	Requirement	Number of cities
Total number of cities covered	186	Size and number of inlets—Continued	
		180 square inches in all (4 sides)	16
Number of walls with inlets:		144 square inches in all	5
4	17	135 square inches in all (3 sides)	19
3	51	120 square inches in all (1 side)	1
2	6	50 square inches (each of 2 sides)	1
1	24	100 square inches in all	1
Separate sides	2	90 square inches in all (3 sides) (UBC)	21
1 for each machine	2	78 square inches in all	2
Required	14	72 square inches per machine	1
No provision	70	72 square inches in all	1
Size and number of inlets:		60 square inches in all	2
24 by 36 inches	1	50 square inches in all	3
2 feet square	1	45 square inches, separate sides	1
18 by 28 inches	1	45 square inches, 1 side	1
15 by 15 inches (each of 3 sides)	1	30 square inches	1
12 by 18 inches	1	No provision	104
8 by 12 inches	1		

[8] Indiana State Fire Marshal Department. Laws and Regulations for Opera Houses, Theatres, Motion Picture Shows, Auditoriums, and Other Places of Amusement. [Indianapolis, 1937]

the decision on this important point is left to individual judgment.

Regulations as to the size of the inlets are established for a smaller group of cities—82 of the 186 covered. There are a number of instances where the minimum number of inlets is regulated by the State or city, but the size is not specified. The largest single inlet requirement—24 by 36 inches—is that of Saginaw, Mich. In St. Louis the requirement is 504 square inches (28 by 18 inches). The Mass. law, affecting 16 cities in the tabulation, provides for 180 square inches in all. Altogether 48 cities prescribe inlets of 100 square inches or larger. In addition, projection rooms in 21 cities, including those subscribing to the U. B. C., must have openings of 90 square inches in all on 3 sides.

TABLE 5

Classification of cities by requirements as to rate of air change in projection rooms

[UBC=Uniform Building Code]

Requirement	Number of cities
Total number of cities covered	186
Rate of air change:	
Every 2 minutes	15
Every 5 minutes	1
Every 10 minutes (UBC)	23
100 cubic feet per minute	1
60 cubic feet per minute	15
50 cubic feet per minute	11
30 cubic feet per minute	6
200 cubic feet per minute (per 80 square feet)	9
280 cubic feet per minute	1
No provision as to rate of change	104

Exhaust. — In Table 4 the cities covered are classified according to size of vent and whether vented to the outer air or to a flue system.

Exhausts carried to the outer air through vents of 10-inch diameter are required under the regulations in 63 cities, including those falling under the U. B. C. In all but 9 cities some provision is made for control of exhausts. Thus 177 cities, or 95 per cent, have some requirement that systems shall be vented to the outer air, only 19 of which do not have a definite specification as to area or diameter. States with legislation on this point include Conn., Indiana, Mass., Mich., Minn., N. J., N. Y., Ohio, Penn., Tenn. and Texas.

Detailed requirements as to equipment to be used and methods of ventilating the projection room proper and the lamp house connected with the machine are not general. Exceptions to this rule exist in the local regulations of Hartford Conn., St. Louis, Mo., and Philadelphia, Pa., which require a complete system of lamphouse ventilation, and in the State laws of Indiana and N. Y.

Air change.—The general lack of specifications for the rate of air change is apparent in Table 5. In only 82 of the 186 cities is there regulation of the rate of air change in projection rooms.

In 23 cities, including those subscribing to the U. B. C., a complete change every 10 minutes is provided for; in every case this is specified in a building code. Conn., N. Y., Penn., and Tenn. are the only State laws covering this point; in Conn. and N. Y. the rate is 60 cubic feet per minute; and in Tenn. it is 50 cubic feet per minute. St. Louis, Mo., in addition to the State of Penn., specifies a complete change of air every 2 minutes. Texas law requires that the room shall be ventilated for the comfort of the motion picture projectionist.

Requirements for the installation of fans are more widespread. In all, 109 cities have such a requirement in their theatre regulations. The lack of general compulsion in the installations of fans in projection rooms may possibly be due to the general acceptance of fans in working places as standard equipment.

To insure safety in projection rooms, numerous precautionary measures have been taken in the larger cities. They

TABLE 4.—*Classification of Cities by Requirement for Projection-Room Ventilation to Outer Air*

[UBC=Uniform Building Code]

Requirement	Number of cities	Requirement	Number of cities
Total number of cities covered	186	Vented to outer air—Continued	
Vented to outer air:[1]		16-inch diameter	15
150-square-inch area	1	14- to 18-inch diameter	5
144-square-inch area	1	12- to 16-inch diameter	16
100-square-inch area	4	12-inch diameter	16
78-square-inch area	11	10-inch diameter (UBC)	63
75-square-inch area	4	8-inch diameter	1
50-square-inch area	12	6-inch diameter	1
18-inch diameter	8	Area or diameter not stated	19
		No provision	9

[1] 10 cities provide as an alternative the use of an incombustible flue; 3 cities, a chimney flue; and 1 city, an approved disposal system.

range from the general provision that doors shall be kept closed during the showing of film (132 cities) and that only persons having business in the room shall be admitted (108 cities), to requirements that fire-fighting apparatus be maintained in the projection room (132 cities), only fireproof furniture be provided (122 cities), and rigid regulations regarding handling and storage of film. While the coverage on all of these points is not so complete as might be desired, the fact that certain cities and States have drafted detailed regulations on these matters may be expected to exercise a beneficial influence in improving standards on a wider front.

General.—In a total of 132 cities, doors of projection rooms must be kept closed during operation. This is a standard of the Underwriters and is also written into the laws of Conn., Ind., Kan., Me., Mass., N. J., N. Y., and Penn.

In a slightly smaller number of cities (109) admission to the rooms during projection of films is restricted to operators, their assistants, and officials of the respective cities and theatres. This is a State requirement under the laws of Conn., Ind., Mass., N. J., and Pennsylvania. In addition 7 cities in Calif., 3 in Ga., 6 in Ill., 3 in Mich., 3 in Mo., 3 in N. Y., 4 in Tex., and 3 in Wash. have restricted entrance through the enactment of local ordinances or building codes; the remaining cities which have taken such action are scattered.

Smoking is prohibited in projection rooms in a larger number of cities. Among the 153 where smoking is ruled out are the cities in Conn., Ind., Kan., Mass., Mich., Minn., N. J., N. Y., Penn., Tex., and Wisc., all of which operate under State laws on the subject.

Special provision for fire-fighting apparatus in projection rooms is established in 133 cities, or approximately 71 per cent of the total reporting. This is a standard in the State laws of Conn., Ind., Mass., Minn., N. J., Ore., Penn., and Tenn., but is not included in the laws of Col., Ill., Mich., Mo., N. Y., Ohio, and Tex.

Fireproof furniture, shelves, and fixtures are required in 121 cities. This is a recognized standard under the Pacific Coast U. B. C. as well as that of the N. B. F. U. Yet only 8 States (Conn., Ind., Mich., Minn., Ore.; Penn., Tenn., and Tex.) have written it into law.

Miscellaneous safety provisions include control of auditorium lights from the projection room. Of the 57 cities in which such control is prescribed, 15 are in Pennsylvania and are covered by State law. To insure enforcement of safety requirements, ventilation, and other standards, regular inspection of machines and rooms is required in 113 cities, including those in Col., Conn., Fla., Mass., N. J., N. Y., Ohio, and Tex. under State laws.

Handling of film.—Of the two types of film, that in common use (cellulose nitrate) is highly inflammable and necessitates definite technique in storage. Table 6 brings together the regulations governing the handling of film as they affect projection room safety directly, and indirectly the safety of the public visiting motion picture theatres.

Permissive legislation for rewinding film in the projection room is common. In 140 cities rewinding in the room is allowed, and some of the States with the most comprehensive laws covering theatres, as well as the National Electrical Code, endorse the practice. The real issue seems to be whether or not it is safe and reasonable for this work to be carried on during the showing of other film by the operator. In 46 cities, where rewinding during operation is forbidden, the consensus seems to be that the two processes should not be simultaneous; this total is heavily weighted by the 16 large cities of Mass. and 13 in N. J., where such operations are forbidden by State laws.

As an additional insurance of safety from explosion of inflammable film, it is required in 175 cities that metal cases be provided for film storage. Thus comparative inadequacy in coverage of cities as to provision for care of film when not in use (137 cities prohibit exposure) is counterbalanced in part by the high proportion of cities where theatre operators must, under the regulations, supply metal cases for film storage.

(TO BE CONTINUED)

TELEVISION & THE ELECTRON

(*Continued from page* 16)

because it is viewed directly on the fluorescent screen of the Kinescope and, consequently, is dependent on the physical size of the tube. *Laboratory experiments indicate that there is every reason to believe that it will be possible to build tubes giving a small picture of sufficient brilliancy to be projected upon a large viewing screen.* Experimental models of this type of projection tube have been made which very nearly meet the requirements of television. Continued improvements in the electron gun and in fluorescent material will unquestionably make this type of Kinescope entirely practical.

These are only two of the many examples that might be given of the progress that may be expected. Next year

and the year after, examples which do not exist today can be given. In other words, the electron system has not yet even emerged from early childhood. Only the most incorrigible pessimist, the man who has an honest doubt about the sun's rising tomorrow, believes that cathode-ray television is a closed field, that all is known about it that can be known.

Assuming that the system as it stands today can produce a fairly satisfactory picture, and that there is every reason to look for marked improvements in the near future, let us ask what will be required of television if it is to become popular in the sense that radio broadcast is popular.

Considering first the receiver: the entertainment supplied by the receiver must be such that it can be made incidental to the normal household activities. In other words, television is not and should not be intended to take the place of the observer's going in person to see an event in which he is intensely interested. The sport fan still will go to the baseball field, the football game or the boxing arena, the theatre-lover still will go in person to see the plays in which he is interested, television or no television.

However, to the individual who is not sufficiently interested in an event to expend the time and effort to become an eye-witness, television will bring a summary of what is taking place. This means that the receiver must be small enough so that it will not be objectionable as a piece of furniture. It must be simple in operation and arranged so that it does not require setting up of viewing screens or any other elaborate preparation. The picture should be bright enough so that it can be readily seen in a moderately lighted room, and small enough not to be too obtrusive, perhaps $1\frac{1}{2}$ x 2 feet in size. In a sense, the receiver might be considered as a window through which the individual may, in the course of conversation or reading, glance to see what is going on in the world around him.

Increased Iconoscope Sensitivity

The television pickup device, to be completely satisfactory, must be sufficiently sensitive not only to reproduce scenes of average illumination but should also be operative at very low light levels. Imagine the feelings of the spectators looking at a football game, if the last few minutes' play cannot be transmitted due to insufficient light. The Iconoscope of today, while it will suffice for ordinary weather conditions, would not be operative in the semi-darkness of late afternoon in November. However, as was pointed out previously, there is every reason to expect a continuous improvement in the *sensitivity* of the Iconoscope as time goes by. Eventually, the Iconoscope may equal or even exceed the photographic camera in sensitivity.

Perhaps the most difficult to attain is a satisfactory *network of transmitters.* At present, the range of an individual transmitter is limited to the visual horizon as seen from its antenna. This means that the area serviced by a transmitter is relatively small, and that each urban center must have its own television transmitters. It is obviously necessary, in a completely satisfactory system, to be able to chain these transmitters in such a way that events can be broadcast nation-wide. These chains will be formed by inter-connecting the stations with means of *concentric cable* and by the use of *radio-relay links.*

This ideal system will eventually exist, but only after years of television broadcasting experience. In the meantime, we will have to be content with a much less perfect system. All the units for satisfactory television are ready and now await commercialization by those responsible for the economic and production aspects of the problem. But, as warning to those who are unduly optimistic, the problem of assembling these elements is almost as formidable as that of developing cathode-ray television.

Universal television in the home will not be an accomplished fact for a number of years to come; but, on the other hand, it is absolutely assured that home reception of pictures will eventually be commonplace.

ACADEMY AWARDS FOR TECHNICAL ACHIEVEMENT IN 1937

(*Continued from page* 15)

cation to production of the Multi-Plane Camera.

This camera has greatly improved the photographic quality and illusion of depth in color cartoons, simplified process work, and is believed adaptable to process and transparency background problems.

To Eastman Kodak Co. for two fine-grain duplicating film stocks.

These two emulsions make available dupli-

cating stock which is an improvement over any previously available, permitting duplication quality very closely approaching that of the original and at the same time markedly reducing the effects of grain size formerly found to an objectionable degree in such films.

Paramount Transparency Camera Setup

To Farciot Edouart and Paramount Pictures, Inc., for their development of the Dual Screen Transparency Camera Setup.

This unit consists of two synchronized photographic cameras driven by a single motor, set up side by side in such manner that adjacent edges of the two fields of view are coincident regardless of distance (from the camera to infinity), permitting close screen action and a screen area of twice the width of the normal camera setup. It photographs with absolute synchronism, action taking place across the two screen areas, regardless of distance from the camera, thus permitting a perspective and panoramic effect not otherwise possible in greatly enlarged projected pictures.

Shearer Variable Scanning Method

To Douglas Shearer and the M-G-M Sound Department for a method of varying the scanning width of variable-density sound tracks (squeeze tracks) for the purpose of obtaining an increased amount of noise reduction.

The application of "squeeze" to variable-density recordings affords an increased amount of noise reduction over that available with other current methods, resulting in greater reproduced volume range in the theatre. The scanning width of the sound track is reduced during periods of normal low modulation and accompanied by a corresponding increase in the percentage of modulation, often resulting in the recording of a truer wave form.

AWARDS IN CLASS III (Honorable Mention in the Report of the Board of Judges):

To John Arnold and the M-G-M Camera Dept. for improvement of the semi-automatic follow-focus device and its application to all of their cameras.

This device facilitates camera operation by correlating the focusing of the shooting lens and finder lens and simultaneously correcting for parallax, with such precision that the position and sharpness of focus in the finder may be relied upon to indicate corresponding properties of the photographic image, thereby materially increasing the speed and accuracy of production photography, particularly in follow-focus shots.

Other Sound Recording Awards

To John Livadary, Director of Sound Recording, Columbia Pictures Corp. for the application of the bi-planar light valve to motion picture sound recording.

The bi-planar light valve eliminates a serious form of electro-chemical distortion caused by the striking together of the valve ribbons during the recording of high-amplitude modulations.

To Thomas T. Moulton and the U. A. Sound Dept. for the application to motion picture sound recording of volume indicators which have peak reading response and linear decibel scales.

This type of volume indicator portrays with greater accuracy the form factor of an electrical wave and permits extension of the useable scale of volume indicating instruments.

To RCA Mfg. Co., Inc., for the introduction of the modulated high-frequency method of determining optimum photographic processing conditions for variable-width sound tracks.

This is the first available convenient quantitative method of establishing optimum processing conditions of variable width sound tracks.

To Joseph E. Robbins and Paramount Pictures, Inc., for their exceptional application of acoustic principles to the soundproofing of gasoline generators and water pumps.

The application of advanced engineering principles to the sound insulation of generators and other accessory equipment has made possible the operation of these units at high efficiency, at points relatively close to the microphone, without noise interference.

To Douglas Shearer and the M-G-M Sound Dept. for the design of the film mechanism as incorporated in the Erpi 1010 Reproducer.

This is an efficient means of obtaining a flutter-free film motion for use in studio recording and re-recording operations, the design of which was completed at M-G-M Studios.

INTERNATIONAL PROJECTIONIST

APRIL 1938

VOLUME 13 • NUMBER 4

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International PROJECTIONIST

With Which is Combined PROJECTION ENGINEERING

Edited by James J. Finn

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MONTHLY CHAT

NOT so long ago we pointed out that many projectionists who display an avid interest in, and are ready to discuss at length, the effect of television on the motion picture theatre, operate projection rooms which evidence either a complete indifference to or ignorance of the fundamentals of the art. We, too, are interested in television and its probable effect on theatre box-offices, and we certainly have no quarrel with those fellows who focus their eyes on the horizon; but we still maintain that this in itself is no excuse for neglecting the present while mooning about the future.

Unquestionably television will have a profound effect upon the picture business: we think that the combination of etherized sight and sound will prove to be unusually tough competition for the theatre. So what? Television is not here yet, and the prospects for its early blooming on a commercial basis are none too bright right now. What this business needs at the moment—from the script writer right down to the theatre service staff—is a return to the fundamental principles that made motion pictures great. This advice is particularly applicable to the projectionist. We suggest a bit more concern about whether the projection lens is clean than about the prospects of television.

INTRIGUING to us, too, are these "inventors" who busy themselves with what they term "foolproof automatic changeovers." This subtle compliment to the projectionist alters not one whit the fact that present changeover units are, like many other things, perfectly satisfactory when used correctly.

Theoretically, there's no great trick about "inventing" an automatic changeover; the job could have been, in fact was, done many years ago. However, experience proved that almost all of these units were something less than "automatic" when subjected to gruelling projection room use day after day: invariably such devices would "go off" at the wrong time—not to mention the servicing problem involved.

This evaluation of "automatic" changeovers is not an attempt to protect our fellows against the onslaughts of labor-saving devices; on the contrary, we welcome any and all advances in the art. But we definitely frown upon those who think that the projection process can be made "foolproof" by mounting on an already overloaded base all manner of trick devices that occasion twice the headaches they are intended to eliminate.

THE second and final installment of the survey of projection regulations throughout the U. S., made by the U. S. Dept. of Labor, appears herein. Read it and ponder on the vagaries of the various regulatory bodies—national, state and local.

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INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 4

APRIL 1938

The Geneva Intermittent Movement: Its Construction and Action

By *A. C. SCHROEDER*

MEMBER, PROJECTIONIST UNION 150, LOS ANGELES, CALIFORNIA

II.

IN THE extremely fast movement no bounce occurs when the pin leaves the slot, but a tendency to bounce exists when the curved surface of the star contacts the lock ring, which may be quite serious. The pin will not completely stop the star, due to the same conditions which started the star so violently, shown in Figs. 4 and 5, last month.

Since the pin leaves the star before the star has stopped, the latter must be stopped some other way. Unless the film tension is abnormal, the point of the star strikes the cam ring at A, Fig. 6, and rebounds, causing the star and sprocket to turn backwards. This is more serious here, because no film tension alleviates the trouble.

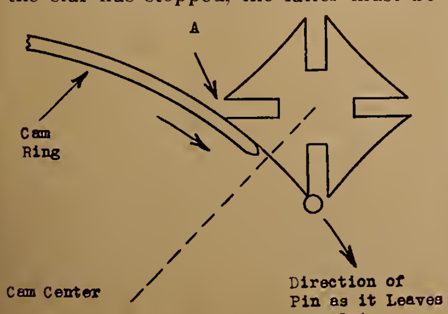


FIGURE 6

While the star is turning clockwise, due to the rebound, the cam is also turning clockwise, so the second contact occurs when the end of the cam ring is somewhere between the position shown in Fig. 6 and the dotted line. The end of the cam ring and the star are moving in opposite directions, resulting in a collision, and due to the position of the parts, a terrific wedging action takes place, tending to force the star and cam apart, and also to bend the two shafts, causing high pressures between the journals and their bearings.

Figure 7 shows the parts at the second impact. The dotted line connects the shaft centers; solid lines are drawn from the star center to the point of impact, and from here to the cam center. The solid lines bend only slightly at the point of impact, being nearly in a straight line and causing extremely high pressures for an instant. A small opening exists at E, showing that the star has bounced, and must again turn in the normal direction (counterclockwise) to close this gap.

When this gap has again closed, the end of the cam ring has moved past the dotted line, and the star is locked in position. Such a movement undergoes a severe beating, and failure is

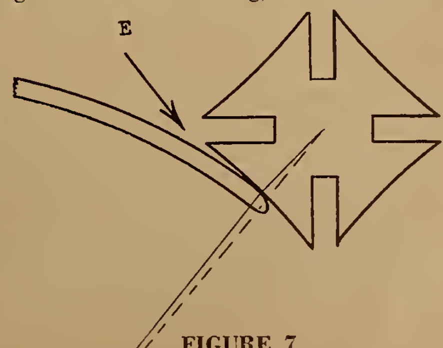
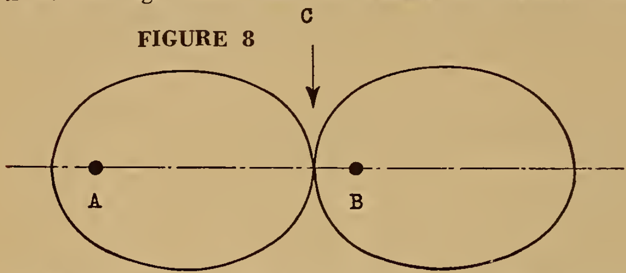


FIGURE 7

only a matter of time. Of course, this treatment does the film no good: a few times through the machine causes

FIGURE 8



checked sprocket holes, and complete failure soon follows.

Effecting Faster Film Transfer

A faster film transfer may be accomplished in other ways. Although results are similar, the parts and the film last longer. In effect, it is as though the projector speeds up—say, to 180 feet per minute—while the film is pulled down. The projector then slows down below 90 feet per minute and runs at this speed until the next film transfer. Actually, the machine runs at 90 feet, but the cam is accelerated when about to move the star, and again decelerated at the completion of the star movement.

The star and cam are so designed that a three-to-one movement results. The cam is driven by a pair of *elliptical* gears having a one-to-one ratio. The shaft is located at one of the foci of the driving gear, making the gear appear to wobble as it revolves. In Fig. 8, A is the shaft center of the driving gear, and B is the shaft center of the driven gear, to which the cam is fastened. Shaft A has a comparatively heavy flywheel, to maintain a constant angular velocity of the driving gear. The driven gear varies greatly in its angular velocity, and the cam is so arranged that it moves the star when the velocity of the driven gear is greatest.

Angular Velocity Ratio of Gears

The angular velocity *ratio* of the two gears varies according to the respective radii of the gears at the point of contact. (The gear teeth are not shown; the gears are shown as two blanks, or friction gears, that would roll on each other as the toothed gears do). The radius of the driving gear *at this instant* is the distance A to C, and BC is the radius of the driven gear.

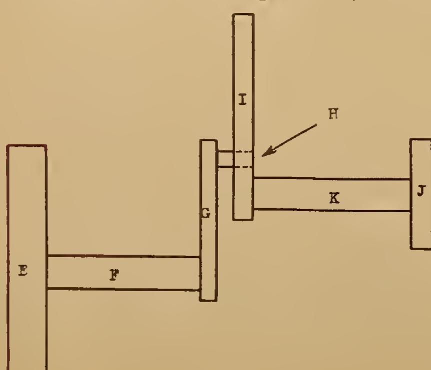


FIGURE 11

This ratio is about five-to-one. In other words, B is turning about five times as fast as A, and consequently the cam is also turning at this speed. At this instant the star and cam are in the position shown in Fig. 2, last month; the star has turned through a 45-degree angle and is turning at its greatest speed, and simultaneously the cam also is turning at *its* greatest speed, thus producing an extremely fast movement.

The angular velocity ratio of the two gears is constantly changing: for each fraction of a degree that gear A turns, gear B turns a different amount, except

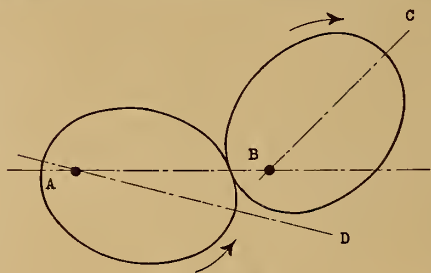


FIGURE 9

at two positions of A, where both gears have the same angular velocity. This holds true, however, for only an instant. The speed of B has been increasing up to the moment shown in Fig. 8. From here on B slows down and continues to do so until both gears have turned one-half revolution. Then B accelerates again, until the position of Fig. 8 is reached once more.

In Fig. 10 both gears have turned one-half revolution from the position of Fig. 8. B now turns about one-fifth as fast as A, thus allowing a long time before the cam pin enters the star again.

Figure 9 shows the gears at the instant the cam pin enters the star, which is 45 degrees before the position shown in Fig. 8. The line BC is drawn through the foci of the driven gear, being 45 degrees from the horizontal line. Line AD is drawn through the foci of the driving gear, being approximately 12 degrees from the horizontal line. In Fig. 8 the foci of both gears coincide with the horizontal line, therefore A turns 12 degrees from the position in Fig. 9 to reach the position in Fig. 8; while B turns 45 degrees during this time.

After the gears pass the position of Fig. 8, the action is similar, but in reverse order. Consequently B turns 45

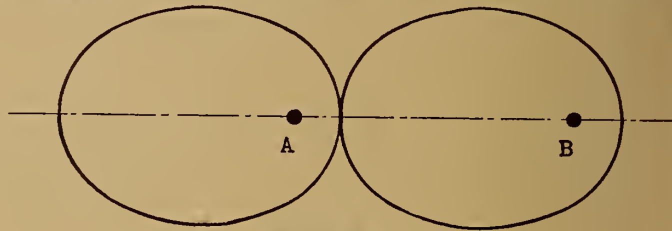


FIGURE 10

degrees past the position of Fig. 8, while A turns 12 degrees beyond this position, and the cam pin is now leaving the star. The total movement of B was 90 degrees, while A turned only 24 degrees, during which time the film was pulled down.

Shutter Movement Relationship

The shutter turns at the same speed as gear A, and for each revolution of A one frame of film is pulled down. A acts just as the flywheel and the cam-shaft in our conventional machine, so we must calculate the speed of the movement from A. Since the film is moving only while the flywheel turns 24 degrees, it remains stationary for 336 degrees of flywheel travel. 336 being 14 times 24, we have a 14-to-1 movement which is some speed, and requires a shutter with about a 24-degree blade. Our regular shutter blade is about 90 degrees.

Obviously, a 14-to-1 movement is hardly practical, and in an actual movement the gears would be more nearly circular. The angular velocity of B would not vary so much, and we would produce a movement with a speed around 5- or 6-to-1.

Elliptical gears are costly and hard to cut without special equipment. Edison, on his last machine, used a system of levers to obtain similar results. Fig.

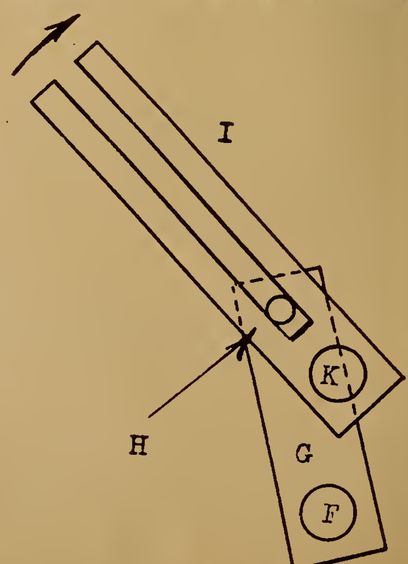


FIGURE 12

11 shows a layout which produces a varying angular velocity of the driven shaft. E is the flywheel, fastened to shaft F, on the other end of which is the lever G. In the upper end of G is the pin H, the dotted lines being a continuation of the pin, which portion is hidden by I, a forked member fastened to the camshaft and shown better in the end view in Fig. 12, the flywheel and the cam J not being shown here.

The dotted lines show portions of lever G which are hidden by the forked member I. Pin H is the only means of transmitting motion from G to I. H is continually sliding in the slot in I. When both levers are vertical (the position they are approaching in Fig. 12) H is very close to the camshaft K, and the speed of K will be much greater than that of the flywheel shaft F. After leaving the vertical position the lever I decelerates, because the pin slides farther away from K as the motion progresses.

In Fig. 13 the levers have almost reached the vertical position again, but in the downward direction. The pin is nearly at the end of the slot, and K is turning relatively slowly. When the levers point straight down, K is moving at the slowest speed, and from here on it again accelerates.

I, in Fig. 12, is 45 degrees from the vertical, and the cam pin is just entering the star. The star movement is completed when I is 45 degrees past the vertical, a total of 90 degrees. Lever G is 16 degrees from the vertical position, and when the star movement is completed it will be the same distance past the vertical, a total displacement of 32 degrees. Here the 90 degrees of cam rotation is obtained by only 32 degrees of flywheel travel. Thus we have 328 degrees of flywheel travel in which the film remains stationary, allowing more time for projection to the screen, deducting that lost due to the flicker blade on the shutter, of course, as we also do in conventional projectors.

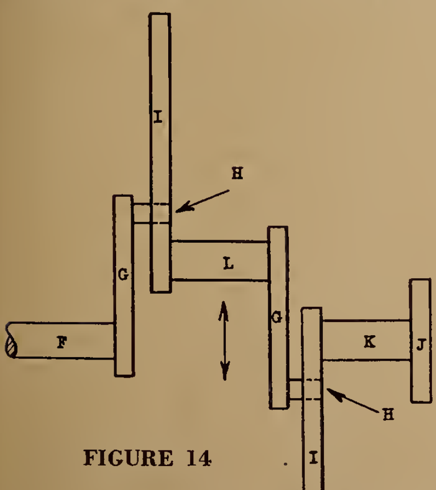


FIGURE 14

If we place the shafts F and K in line with each other, we find that the pin does not slide in the forked member I, but remains fixed in one position, relative to I, although both levers are revolving. The angular velocity of I, then, is constant and equal to the driving member G. No advantage is obtained from the levers, and the movement has a three-to-one ratio, requiring 90 degrees of flywheel travel to effect the film transfer.

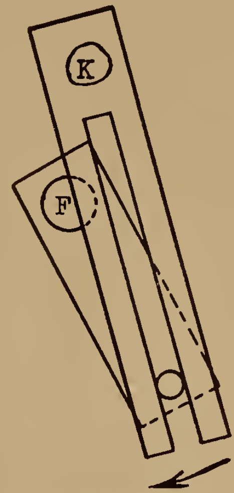


FIGURE 13

If camshaft K is displaced only slightly from the in-line position, the pin moves slightly within the forked member and the speed of I begins to vary, increasing as the levers move in an upward direction, decreasing as they move in the downward direction. The amount of speed variation depends on how far the shafts are out of line, and if I, J, and K are arranged so that they can be moved relative to shaft F, then the *variation* of camshaft speed can be changed at will.

The Old Edison Method

This is what Edison did. Obviously, the cam and camshaft cannot be moved very easily. (These parts actually move in all our machines, but this is done for framing). Edison used two more levers, as in Fig. 14. Both driving levers are marked G, both pins are indicated by H, and the forked levers are I. Notice the third shaft L, which is moveable in an up-and-down direction, indicated by the double-pointed arrow. When L, together with the two levers fastened to it, I and G, is moved downward so that it is in line with F and K, the drive is straight through, just as though F and K were connected by a shaft, and no variation in the angular velocity of K results.

As shown in Fig. 14, pin H in the first lever is very close to shaft L, causing a large variation in the speed of L, the latter being shown at the position where its speed is greatest. At the opposite end of L the lever G points straight down, and *its* pin is close to shaft K, and K turns at its greatest speed. The condition is such that the speed variation is multiplied; not only has the speed of L been greatly increased, but at the same time L, through means of *its* lever G increases the speed of K, and consequently the speed of cam J.

In Fig. 15 the parts have turned one-half revolution from the position in Fig. 14. The first two levers have greatly slowed down shaft L, which in turn has slowed down the camshaft by means of the second pair of levers. By the use of this double system of levers the effective speed of the movement can be changed without moving the camshaft; only the shaft L and its connected levers are moved up or down. This causes no complications, because the only connection to L is through the two pins H, which are free to move in their respective slots.

The actual displacement of L from the in-line position was only a small amount. A larger displacement causes so great an increase in the speed of the movement that the film simply cannot stand the terrific strain. This strain is not due to the conditions set forth in Figs. 3, 4, and 5 last month, because our present cam and star is actually a 3-to-1 movement and operates as shown in Figs. 1 and 2.

Slight Speed Increase Possible

But even such a movement will, if the projector speed be increased enough, strain and eventually tear the sprocket holes. This is what happens when the movement is accelerated by a system of levers or through the use of elliptical gearing. Only a slight increase in speed is therefore permissible, and each increase calls for greater film tension to assure the film stopping in the proper position. Of course, the increased tension produces more strain on the film during the period in which it is started and accelerated.

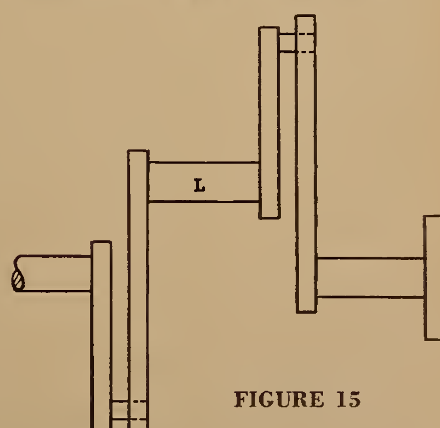


FIGURE 15

(TO BE CONTINUED)

Modern Martini Theatre, Galveston, Texas, profits with modern RCA Magic Voice of the Screen

Grading Projectionists in Canada

By *G. P. BARBER*

CHIEF INSPECTOR OF THEATRES, PROVINCE OF ALBERTA, CANADA

THE purpose of theatre regulations in the Province of Alberta (Canada) is to give public protection against panic or serious mishap in the event of film fires in projection rooms. That purpose has been developed to include general precautions covering width of aisles, door spacing, seating arrangement and fire-prevention measures within the auditorium, or that total enclosure that is known as a theatre.

As film fires occur chiefly in the projection room, any measure that tends to confine or limit such fires to the projection room is considered as treating the danger at its source. This paper, however, will not consider details of construction, or projectors and equipment, but will deal with the importance of licensing and progressively grading the persons who work in projection rooms and who are in charge of projection equipment during the time the theatre is open to the public.

Over a period of several years Alberta has been privileged, with the friendly assistance of its exhibitors and projectionists, to build up a system of issuing certificates to projectionists that it is believed represents a major factor in fire prevention. In addition, the life of current prints is prolonged under competent handling, and prints are less subject to premature mutilation than would be the case if novices were employed in place of the trained and experienced men.

First License as Apprentice

A person wishing to take up projection work in Alberta is required to obtain an apprentice license. The application for such license is in the form of an affidavit, and must be signed by three persons, namely, the proposed apprentice, the manager or owner of the theatre, and the projectionist under whom the apprenticeship is to be served. The object of this threefold preliminary is to establish the good faith of the application: to insure that the owner of the equipment has consented to let his property be used; to guarantee that a projectionist is willing to act as teacher or instructor; and to start a genuine record of the apprenticeship so that the required projection room service may be readily traced when the apprentice is ready for his initial examination.

The apprenticeship must cover a period of at least twelve months, with not less than 300 hours of actual projection room instruction on standard 35-mm. equipment. Examinations are held quarterly, and assuming that the apprentice has fulfilled the requirements as to length of time and hours of training, he may sit for the initial third-class examination. All examinations are written, but the examiner may test the ability of the prospective applicants on their own equipment from time to time while on inspection work in connection with the theatre.

Methods of licensing projectionists in the Province of Alberta are described in the accompanying paper, first presented before the S.M.P.E. Comments on the apparent benefits derived from the process are included. Becoming a first-class projectionist requires a licensed apprenticeship of at least twelve months, followed by one year as third-class and, later, one year as second-class projectionist before taking final examination for a first-class license. Each period, except apprenticeship, is preceded by a thorough examination.

The successful apprentice in the initial examination is granted a third-class certificate, which enables him to hold a position as assistant in small theatres and so to continue the next period of twelve months together with at least another 500 hours of actual projection room experience. His next examination, which is for second-class, is advanced in both theory and practice over his initial attempt and is intended to represent the next higher standard attainable with the normal growth and development of the progressing candidate. If successful, he is given a second-class certificate, on which the same period of twelve months is again required, but with not less than 600 hours of additional projection room experience in a second-class theatre before he may sit for first-class examination.

Fees for Various Classes

Applicants coming from places outside the Province of Alberta are required to furnish proof of their experience as projectionists before examinations will be granted. This proof may be in the form of letters from former employers or the original license, if such license was required in the territory in which they claim to have been employed.

Examination fees are $15 for third-class; $20 for second-class; and $25 for first-class. These fees cover the issuance of certificates but are forfeited should the candidate fail to pass the examinations. The casual observer might be inclined to call these fees excessive, but a little reflection will show that they induce a more serious attitude of mind on the part of prospective candidates than is the case when the financial consideration is negligible.

The examination is primarily designed to prove the candidates' understanding of projection room practice in its various phases, and a certificate is intended to certify that the holder thereof is familiar with the work that his employer expects him to perform. The fee is likely to deter the trifler, but it lends incentive to the serious-minded candidate in the study of real projection problems.

Theatres are graded according to seating capacity. A place with 500 or more seats requires two first-class projectionists, one for each projector. Two second-class men are required in theatres with less than 500 but more than 350; below three hundred and fifty seats, one second-class man in charge with a third-class assistant. Apprentices are not employed in place of licensed projectionists, and not more than one apprentice is allowed to each theatre at any time.

Certificates are issued as from January 1st of each year, and expire on the 31st of December of the year of issue. First- and second-class certificates are renewable without re-examination, but holders of third-class certificates have the option of trying for second-class or rewriting for third-class, as that class is not renewable. This policy has been adopted as tending to urge the beginner to reach the higher grades.

Question papers are changed and modernized from year to year, and no candidate receives the identical paper twice. Questions are arranged numerically under the general headings of mechanics, optics, electricity, and safety. There are thirty questions in the third-class examinations; fifty in the second-class; and seventy in the first-class. The percentage required to pass is 60 for third-, and 80 for second- and first-classes.

Should a candidate be dissatisfied with

the markings of the examiner, provision is made for the Board of Appeal, consisting of a representative of the Government, a representative of the exhibitors. and a representative of the licensed projectionists. The findings of this Board are binding upon both the candidate and the examiner alike; there is no higher appeal. While there have been many failures in past years, especially in the lower grades, the percentage of appeals has been almost nil, as the sincere candidate is fully aware of his shortcomings immediately the examination is completed; and as the whole procedure is obviously not to trick or hinder but to encourage and educate the applicant right from the early stages, the entire system builds up a spirit of confidence not only in the methods followed but also within the candidate himself, which makes for friendly cooperation among all concerned.

Advantages of License System

Generally speaking the system of licensing is of benefit all around. Those supplying films are assured that reasonable care will be taken of their prints, since the men to whom they are entrusted are experienced and have "grown up" in the work of projection. Every projectionist must sign a complete film report for every item on the program (feature, comedy, and shorts) at the end of custody of each run of pictures. A copy of this report is sent to the Department and one to the film exchange. A third copy is retained for projection room records. We thus have accurate knowledge of the condition in which the film was received at any particular theatre, the number of times it was projected, who projected it and what. if any, trouble was encountered.

Exhibitors now depend upon the licensing system in selecting projectionists, and projectionists are protected from the "fly-by-night machine operator" who usually may be depended upon to leave behind him a lot of trouble for the projectionist to clean up.

It is believed that our examination fees are effective in compelling study. No candidate likes to fail, but to fail and lose money in addition makes the sensation doubly painful, since he not only gets nowhere but he foots the bill for the experience. Then there is the matter of three examinations, third-class, second-class and finally first-class. If he is to "arrive" at all, he soon comes to the conclusion that study, assimilation, and practice are essential to his progress.

Our biggest problem has been to combat the argument that such restrictions are not enforced or even suggested in other places, *etc. etc.* That is why we welcome symposiums such as are presented at SMPE conventions. We feel that if similar systems could be established throughout this whole continent, there would be better prints, better all-round projection, and considerably less willful, careless, and useless waste.

It has been the wish in this paper to outline briefly a system of licensing that has for its main objective the purposeful conscientious study and application of projection knowledge on the part of those who spend the greater part of their working hours in projection rooms, and who are charged with the responsibility of putting the picture on the screen. These men, known as projectionists, can either make or mar the work of film producers and their staffs. It is believed, therefore, that aside from the public safety angle, any prevention of waste in the form of mutilated prints is worthy of the best consideration of governments, examiners, and the serious-minded throughout the entire industry.

DISCUSSION:

MR. KESSLER: For the past thirty years as a member of Local 306, and, prior to that, Auxiliary 35, I know it to be a fact that the examinations we formerly took on Park Row (New York) and the examinations that are taken today are given in the same old-fashioned way. Nothing has been improved. It would be a good idea if the engineers of today would take it upon themselves to go down and show the City Department how to examine projectionists.

MR. HOVER: I believe a number of members here are familiar with the stumbling block of the system. If our engineers and projectionists could find a way of rooting out politics from the examining boards, there would be no trouble.

MR. RICHARDSON: One bad feature of projection examinations, aside from politics, is that our laws take cognizance of practically only one thing, so far as concerns examinations, and that is fire hazard. No attention is paid to the hazard to eyesight, to the ability to put an image on the screen in such a way that there will be a minimum of eye-strain; and yet the shows increase in length until now they are three hours long. The law pays no attention to the quality of projection.

MR. FINN: I question the necessity for the distinction made in the paper between, say, a 600-seat theatre and a 750-seat theatre, from which it would appear that the need for good projection is not so pressing in the former as in the latter.

Canadian procedure makes quite a point of examining the applicant on what they term "his own equipment." That permits a man to be a fine projectionist in one theatre and probably a very bad one in another house with different equipment.

MR. GREENE: The great majority of us have probably long since reached the limit of patience with law-making and law-enforcing bodies; we no longer expect anything of them, and are content if we can just keep them from doing too much harm. All the more it becomes the obligation of each local to assume as its own duty and responsibility that of safeguarding the public, and to insure the excellence of the performance they place before the public. They would be quite satisfied if through their own efforts they were able to do that without too much interference from politics. Fortunately, there is an increasing proportion of union members who are not primarily interested in politics, either inside or outside their own organizations.

Color Films, Sound Recording, Reproduction Feature S. M. P. E. Papers Program

MANY and varied papers on color motion pictures, reflecting the rapidly expanding color feature production schedules, highlighted the paper program of the Spring Meeting of the Society of Motion Picture Engineers, held at Washington, D. C., April 25-28. Refinements in the sound recording process were next in order of importance on the program, which was unusually diversified.

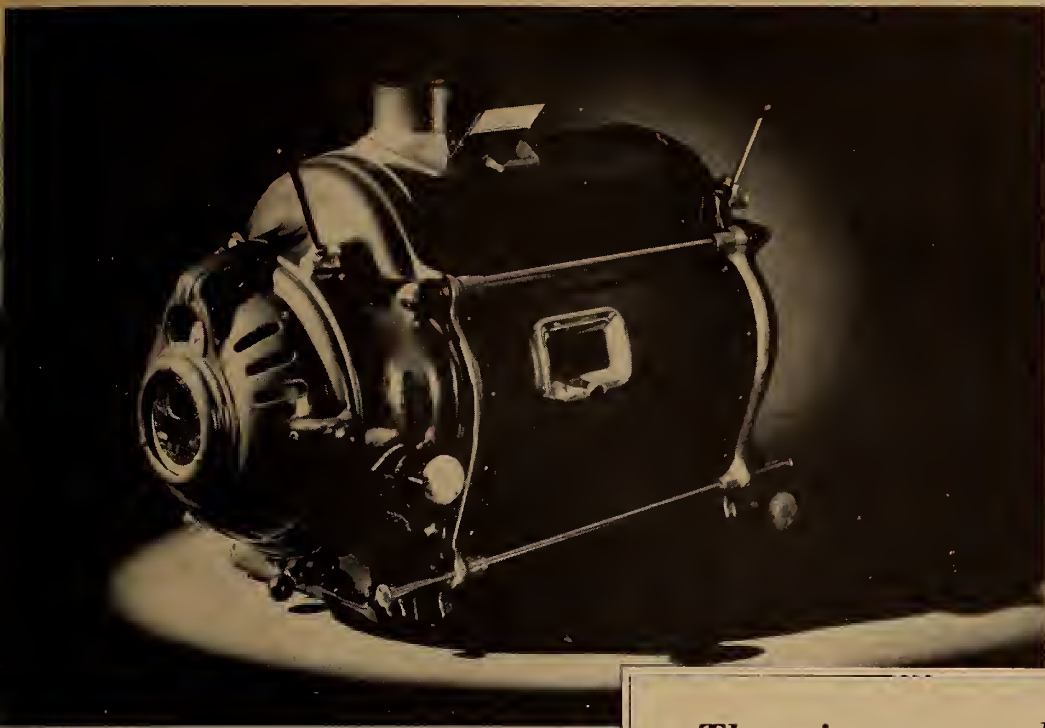
Excellent progress on a long and arduous task was noted in the report of the Projection Practice Committee, which is now and has been for some time past engaged in a comprehensive survey of American theatres in an effort to increase materially the level of screen illumination. This is a many-sided problem, involving consideration of the entire projection process and including projection room equipment, auditorium characteristics, the screen, suitable meter equipment for checking, etc. This report will be presented herein in its entirety at the earliest moment it is made available.

Advances by the manufacturers of film stocks were noted by the Progress Committee, which cited Agfa Ansco for high-speed panchromatic emulsions, Eastman Kodak for two fine-grain duplicating stocks, and Du Pont for a new sound emulsion. These new stocks contributed greatly to the wide advances scored in sound recording and reproduction during the past year.

Reconsider Metallic Film Stock

Metallic film once more claimed the attention of technicians by means of a paper which detailed the progress being made in the hunt for a new photographic base. An abstract of this paper, which induced a wide divergence of opinion among the assembled technicians, is appended hereto and stakes out the claims made for this new photographic base. It appears that the use of such a

(*Continued on page* 26)



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PROJECTION

Chaotic Status of Laws Anent Projection Technic, Equipment, Rooms Revealed by Nation-Wide Survey

COMPILED BY BUREAU OF LABOR STATISTICS, U. S. DEPARTMENT OF LABOR

II.

AS AN additional insurance from explosion of inflammable film, it is required in 175 cities that metal cases be provided for film storage. Thus comparative inadequacy in coverage of cities as to provision for care of film when not in use (137 cities prohibit exposure) is counterbalanced in part by the high proportion of cities where theatre operators must, under the regulations, supply metal cases for film storage. The inference is that if such cases are available, the projectionist, a trained craftsman, will make use of them, knowing the existing hazards.

Conn. law has both types of regulation, as do also the laws of Ind., Mass., Mich., Minn., N. J., N. Y., and Penn. Ohio and Wisc. provide only that metal cases shall be supplied for storage. This is in conformity with the terms of the U. B. C.

Slightly less than 71 per cent of the cities (132) require the installation of containers in projection rooms for placing hot waste carbon as it is removed from the projector. In a relatively high proportion of cities this standard is written into city ordinances, and there are a few building codes which cover this subject; but in the largest number of cases it is a matter of State law (Conn., Mass., N. J., N. Y., and Penn.)

Storage of film.—As provisions for film storage affect projection room safety and also the safety of the theatre public, the number of cities having regulations requiring permits to store, storage of film in vaults, and fire-prevention measures in the vaults are given in Table 7.

TABLE 6.—*Classification of Cities by Requirements as to Handling Film in Projection Rooms*

[NEC=National Electrical Code; UBC=Uniform Building Code; and NBFU=National Board of Fire Underwriters]

Requirement	Number of cities
Total number of cities covered	186
Rewinding in projection rooms:	
Permitted (NEC)	140
Forbidden	8
No provision	38
Rewinding during operation:	
Permitted	32
Forbidden	46
No provision	108
Metal cases for film storage:	
Required when not in use (UBC)	175
No provision	11
Container for hot waste carbon:	
Required (NBFU)	132
No provision	54

In most of the 35 cities where theatre owners are required to obtain special licenses to store film, the requirement is under a municipal ordinance, a local fire-prevention code, or police regulation. Conn. is the only State that has legislation providing for a license of this kind.

In 74 cities film vaults must be maintained according to public regulations. In the 13 New Jersey cities covered, the State law permits the keeping of only enough film in the room for 1 day's showing; all other film must be stored in a vault off the premises. Except in Conn., Ind., and N. J., there are no State regulations on this subject. Among the 54 cities where either ventilators or sprinklers or both are required in the vaults, the 5 covered by the Conn. law are included.

Machines and Equipment

In most instances regulations do not lay particular stress on the kinds of machines, enclosures, or guards that should be used to secure safety in projection rooms. Once the law has provided for sound room construction, public control of projection rooms gives way to private regulation. Owners are then free to install such equipment as they choose, subject to the approval of the underwriters with whom they may insure. It is customary for theatres to make installations in such a way as to comply with the terms of the National Electrical Code[9] as recommended by the National Fire Protection Assoc., thus meeting recognized minimum standards.

The N. E. C. contains an article dealing especially with motion-picture projectors and equipment. The first requirement is that the so-called "professional" types of projectors, such as are commonly used in motion picture theatres, must be located in fireproof rooms. All live parts must be enclosed or otherwise guarded to prevent accidental contact of persons or objects. Proper grounding of all conduit, armored cable, metal raceways, exposed metal frames, and enclosures of equipment is required.

[9] 1935 edition, pp. 244-246.

All projectors, including the lamp house for arc or incandescent lamps, must be designed for this particular purpose and must be approved. Lamp enclosures are required to bear the trade-mark of the maker and the name of the current and voltage for which they are designed. There are technical requirements as to wire size, and the rheostats, transforming devices, *etc.*, must be of approved type. Top and bottom magazines must be so designed as to prevent the entrance of flame, and no solder may be used in their construction. The front of each magazine must consist of a door swinging horizontally and equipped with a substantial latch.

A provision is included for an automatic shutter, permanently attached to the gate frame, so constructed as to shield the film from the beam of light whenever the film is not running at operating speed. The code also states that motor-driven projectors shall be of a type designated and approved for such operation, and that they shall be placed in the charge of a qualified operator.

Enclosures for projectors of professional type are limited to fire-proof construction, permitting a working space of not less than 2 feet on either side and rear of each projector. There is a provision that ventilation shall be by a vent pipe having inlets at one or more points in the ceiling, but supplementing the requirements on ventilation in State and city laws, (see above). The vent pipe must connect with each arc-lamp housing and lead either to the outer air or to a noncombustible flue. All pipes must be kept at least 1 inch from combustible material or separated therefrom by approved noncombustible, heat-in-

TABLE 7.—*Classification of Cities by Requirements for Film Storage*

[NFBU=National Board of Fire Underwriters]

Requirement	Number of cities
Total number of cities covered	186
Permit to store:	
Required	35
No provision	151
Film vaults:	
Required (NBFU)[1]	74
No provision	112
Ventilator and sprinkler systems in vaults:	
System required (NBFU)	54
No provision	132

[1]New Jersey State law requires that only enough film for 1 day's showing be kept in the booth, and that a storage vault be maintained off the premises. This affects 13 cities.

sulating material not less than one-half inch thick. Draft is required in each booth vent pipe, to be maintained by an exhaust fan having a capacity of at least 200 cubic feet per minute for each 80 square feet of floor area.

All openings in the enclosure are required to be fire-resistive and have doors or shutters that may be kept closed by spring hinges or equivalent devices. All openings must close automatically should the room temperature adjacent to the top magazine of any projector exceed 165° F. Wiring is provided for in detail.

Labor Requirements

State laws or city ordinances often require that motion picture machine operators shall be licensed. Such regulations include age requirements, make provision for examination, state the charge for a license, and in some instances include a provision that licenses may be revoked for just cause. In Table 8 requirements for licensing projectionists are tabulated by number of cities having each.

Of the 117 cities in which a minimum age is established for licensing operators the largest proportion (67) have a minimum-age requirement of 21. In 1 case the age is 20 and in 49 cities it is 18 years. Regulations governing the remaining 69 cities for which information was obtained do not cover this point. Seven State laws—those of Conn., Fla., Mass., Mich., Minn., N. Y., and Penna. —make an age requirement, the Conn. and Mass. laws specifying 21 years, the N. Y. law "full age" (assumed to mean 21 years), and the remaining laws, 18 years. Where cities fix the age, it is more often by municipal ordinance than by other types of regulation.

A license to operate machines is required in 117 cities, and in the great majority of cases a fee is charged for it. States requiring that projectionists shall be licensed are Conn., Fla., Me., Md., Mass., N. J., N. Y., Penna. and R. I. Annual fees run from $1 to $10 in most cases. In a number of cities the amount is higher for the first year than in succeeding years, as, for example, $10 for the first year and $5 thereafter in Baltimore, Md.; $5 the first year and $1 annually thereafter in Cleveland, Ohio; and $3 the first year and $1 annually thereafter in Roanoke, Va. Cities for which the regulations do not state the amount of the license fee include Oakland and San Francisco, Calif.; Cedar Rapids, Davenport, and Sioux City, in Iowa; and Nashville, Tenn. In Lansing, Mich., the building code prescribes a $1 fee, but thus far this has not been collected.

In 113 cities a projectionist must pass an examination before he is licensed. This number includes the 10 Michigan cities where the State fire marshal is empowered to examine candidates at his discretion, and 3 Minnesota cities where examination is also optional. Examination is compulsory, under the statutes of Conn., Fla., Mass., N. Y., and Penn. Among the 90 cities where it is stipulated that licenses shall be revoked for cause are those operating under the Conn., Mass., N. Y., and Penn. State laws.

A few States and cities have established what is in effect an apprenticeship system by the terms of their regulations on licensing. In Lansing, Mich., an applicant must have 2 years' experience. In Florida he must have served for 1 year under an experienced operator before applying for a license. This is also the standard in several Illinois cities. The Maryland, N. Y., Penn., Washington, D. C.; Kalamazoo, Mich., and Rochester, N. Y., codes specify 6 months of apprenticeship. Mass. establishes a system providing for three classes of operators. To secure a second-class license, 3 months' experience under a first-class operator is necessary; to secure a first-class license, the applicant must have held a second-class license for 3 months and have worked regularly on a hand-driven machine; and to qualify for a special license, a first-class operator must take an examination on operation of both motor and hand-driven machines. As the operator qualifies for successively higher-grade licenses the age requirement and fee are higher.

The theatre laws of Ill. and N. Y. states, affecting 19 cities in this survey, stipulate that motion-picture operators shall have 24 hours of consecutive rest per week. In Chattanooga, Tenn., a 6-day week is prescribed by municipal ordinance.

Deficiencies in Regulations

From the foregoing discussion it is evident that a need exists for extension of the laws and regulations governing conditions in motion picture projection rooms, to secure public standards where none exist, to raise those which are low, and to insure greater uniformity. Whether this task should be undertaken on a State basis, by cooperative action between states, or in the individual cities is a matter for careful consideration by those in the industry and by the respective governmental agencies. If past experience is any criterion for establishing future control, it should be stressed that good State laws expedite accomplishment of the desired ends.

In the enactment of such laws, use may be made of the expert knowledge of local officials, theatre owners, and labor. In this way there is only one cost for investigation and codification in each State. Because of the cost involved, individual city governments, which sometimes experience difficulty in securing funds even for printing city codes, may often postpone studies to establish standards. Of the regulations now in force those contained in State law are outstanding.

Certain comparisons of existing laws and regulations may be drawn. In writing motion picture laws the State governments have tended, after framing regulations with considerable care, to make few amendments. There have been no striking alterations as conditions have changed. In fact, often the only provision modified has been that establishing a license fee for theatres. The amount of this charge was in some cases reduced during the depression period. In common with State laws, municipal ordinances for theatres have remained substantially in their original form.

As contrasted with State and municipal regulations, building codes have greater flexibility, changing with the technical developments in the construction industry. The Pacific Coast U. B. C., for example, was revised early in 1937. While, as has been emphasized, this code covers only a small proportion of the cities included in this survey (less than 1 per cent) and they are in most cases geographically centered, its adoption by a large group of cities is significant in that it is a pioneer movement looking toward intercity and interstate action to raise construction levels. A number of individual cities have rewritten their building codes in recent years, for example, Los Angeles, 1937; Wilmington, Del., 1936, and Springfield, Mo., 1935, and the N. Y. City building code has only recently been revised and adopted to become effective Jan. 1, 1938.

Of the 186 cities for which information was complete enough to permit inclusion in this study, 161 operated under a State law of sufficiently broad coverage to influence working conditions materially. All of the States made some provisions for motion picture theatres, but where only licensing, or the method of door construction and installation of fire escapes, are regulated, cities in such States have not been classified in this study as operating under State law. The 12 States without comprehensive legislation are: Ala., Ark., Ga., Me., Md., Neb., Okla., S. C., Utah, Va., Wash., and W. Va.

Building codes and municipal ordinances touch on motion picture theatres more often than other kinds of local regulations. Many cities have provisions on theatres in both their building codes and municipal ordinances. In a small number of cases the provisions of the State law, building code, or municipal ordinance, or any two or three in combination, are supplemented by the local electrical code, fire-prevention measures, or police codes. As cities customarily comply with the National Electrical Code, little local regulation is needed for electrical installations.

TABLE 8.—*Classification of Cities by Requirements for Licensing Motion-Picture Machine Operators*

Requirement	Number of cities
Total number of cities covered	186
Minimum age of operator:	
21 years	67
20 years	1
18 years	49
No provision	69
Licensing of operator:	
License required	117
No provision	69
Examination of operator before licensing:	
Examination required [1]	113
No provision	73
Revocation of license for cause:	
Specified	90
No provision	96

[1] Includes 13 cities in which examination is optional.

Technical Data on New Simplex Sound System

FOLLOWING closely the introduction of the Simplex E-7 projector, International Projector Corp. has completed the chain of sound and visual reproduction equipment from projector head to backstage loudspeakers by announcing the new Simplex Four Star Sound System. This system is licensed to employ patents and design features of both Western Electric and RCA.

On the two pages immediately following there appears a graphic story of this new Simplex system, complementing this brief description of some of its more outstanding features. Of particular interest is the announced policy of International Projector Corp. relative to co-operation with the field by making available every bit of data that should prove helpful in maintaining the equipment, as detailed elsewhere on this page.

Noteworthy is the fact that there is only one Simplex Sound System, that is, all installations, regardless of size, are warranted to reproduce with the same high-quality characteristics, regardless of auditorium proportions. Only one type of soundhead is provided for all installations, along with the same quality of amplifier, speaker network, speakers, etc. The only variables are the number of power amplifiers operating in parallel to provide the proper power output, and the type and number of loudspeakers to provide adequate distribution and power handling capacity which is obviously required in the larger theatres. This is expected to be a tremendous boon to the smaller theatres, which heretofore have been supplied sub-standard equipments.

One of the principal limitations to volume range to date is the development of extraneous noises in the sensitive amplifier circuit. This is often caused by dirty and imperfect contact in the sound signal circuit, by the vibration of transformer lamenations, in circuits where iron core transformers and chokes are employed.

In the Simplex Sound System the number of mechanical contacts in the signal circuit from the photoelectric cell to the loudspeaker voice coil has been reduced to a minimum. The main amplifier volume control and the sound changeover have been placed in isolated circuits. The only switches in the circuit are those for testing loudspeakers and are not used during normal operation. The individual volume controls are of special design to eliminate the introduction of noise from dirty sliding contacts.

The reduction of the number of transformers and chokes materially reduces the noise level and greatly improves stability. The use of coaxial cable, such as is used for television wire transmission, to couple the photoelectric cell and the volume control amplifier further reduces noise. Thus, a much greater volume range is made available which adds realism to the reproduced sound.

Some of the more important features of this new equipment are: Main ampifiers are all designed to permit parallel operation through simply isolating the faulty unit by operating a switch. Volume control amplifier cabinets are designed to accommodate two amplifiers and suitable switches. In the event one fails, operation may be instantly continued on the other.

A power unit is provided to furnish d.c. to the exciter lamps for high quality reproduction. The operation of a switch permits instant illumination of the exciter lamps from a.c. current through a separate transformer. The use of modern permanent magnet field dynamic loudspeakers eliminates the requirement for a power unit to supply field excitation. Either loudspeaker in the system can be operated in case of emergency by simply throwing the switch.

The soundhead is of a rotary stabilizer type, and all of the optical system, including photocell, is isolated to the left-hand side, with all mechanical units to the right-hand side, thus leaving a free path for threading the film. The photocell is mounted vertically to eliminate vibration of the cathode.

The exciter lamp is of the pre-focus base type, but adjustments are provided to correct even the tolerance allowed by the manufacturer on this type of lamp. All optical and and scanning parts are resiliently mounted, and the entire assembly is removable as a unit.

The gear box as a complete assembly is readily removable from soundhead main frame, and all parts therein operate in an oil bath and on ball bearings.

The soundhead is equipped with flywheel and brake and has a starting time in accord with S.M.P.E. standards.

Amplifier, speaker network and exciter lamp rectifier are all mounted in a wall cabinet which may be placed anywhere in the projection room. All units in the cabinet may be slipped out and inverted for instant servicing. The hum level of the system is minus approximately 36 db.

The amplifier is provided with meter and switch for checking the tubes, the meter having red and green areas and indicating any defective tube. The speaker network is provided with horn test switches in high- and low-frequency units, with provision for carrying entire show on low-frequency unit in case of emergency. The network changeover is at 400 cycles.

A monitor control is provided on the speaker network panel either with or without monitor amplifier as desired. A headset monitoring jack is provided on speaker network panel, plus means for making volume indicator runs without cutting into the circuits.

Rectified d.c. is supplied by the exciter lamp rectifier for d.c. exciter lamp operation, plus an emergency switch for a.c. exciter lamp operation in case of failure of rectifier tubes, with provision for operating second exciter lamp at glow temperature up to changeover period.

The photoelectric cell is connected through a coaxial cable having extremely low impedance to front wall electronic volume, or gain, controls having 38 db. gain in 2 db. steps, with an additional adjustable gain at the main amplifier of approximately 70 db. Provision is made for remote volume control, push-pull and even stereophonic reproduction, when available. Post-equallization is available for pre-equallized prints, when released.

High-frequency horns of the true multicellular type are supplied with all systems from the smallest to the largest, together with folded low-frequency baffles

(*Continued on page* 26)

Bravo! for a Sensible Servicing Program

To the Editor of I. P.:

As you know, we recently announced our Simplex Sound Systems to the trade, and we have already made a few installations here and there throughout the country.

I am sure that you will be interested to know of the policy we are adopting in connection with this apparatus. With every shipment of a sound system there will go full instructions for its installation and servicing, together with *complete schematic and wiring layouts*, so that anyone capable of reading drawings of this nature can readily follow the circuits and take care of any emergency which may arise.

These drawings and other data will be complete with the values of all components entering into the entire system, so that there will be at hand at all times the necessary information either to prevent or quickly eliminate a sound outage.

Herbert Griffin
International Projector Corp.

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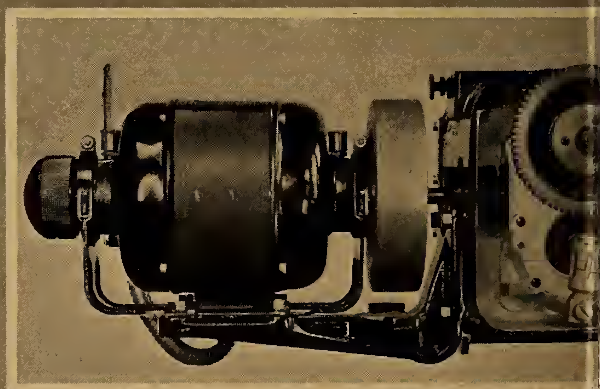
Main amplifier cabinet, enclosed type of sturdy three-section construction, designed for floor or wall mounting. Louvers on front and sides provide adequate ventilation. Front panel clips in place. Quickly and easily removed without the use of tools.

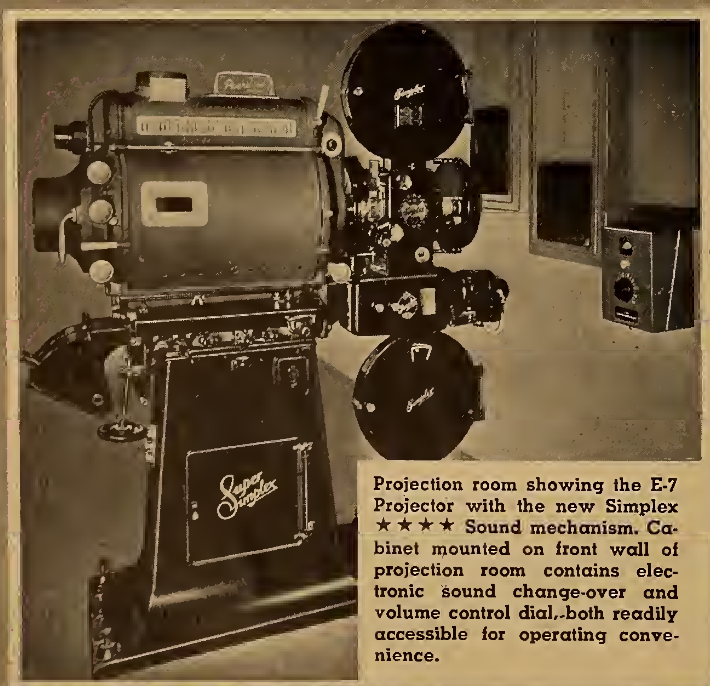
Volume control amplifier designed for mounting on front wall of projection room to avoid vibration. May be partially recessed in wall for concealment of wiring. Electronic sound change-over instantaneous, positive and silent in action. Large convenient control dial.

Unit construction and assembly features unique drawer arrangement. By removing front panel, chassis may be slid forward, giving easy access to all parts for examination.

Power amplifier employs resistance coupling for quality. Power output 15 watts at any frequency with less than 1% total harmonic distortion. The elimination of iron core transformers and reactors reduces noise. Power circuit is separately fused.



Sound-head new and improved rotary stabilizer design. Features: Pre-focused exciter lamp, oil-proof optical system, improved scanning light reflector, lateral film guide and pressure rollers, plus unit assembly of entire sound pick-up, and drive mechanism.



Projection room showing the E-7 Projector with the new Simplex ★★★★ Sound mechanism. Cabinet mounted on front wall of projection room contains electronic sound change-over and volume control dial, both readily accessible for operating convenience.

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SIGN

High-frequency loudspeaker, genuine multi-cellular horn. Spherical mouth opening of new design and 8-cell construction for better quality and wide angle distribution. Permanent magnet dynamic driving unit incorporates high safety factor in relation to power required in normal operation.

Two-way loudspeaker system supplied with all equipments to assure highest quality reproduced sound and uniform distribution. Low-frequency speaker, folded exponential horn of wood construction throughout.

An additional feature provides for 180° rotation of chassis which exposes all wiring and connections. Operation is not interrupted when in this position, which permits convenient servicing or testing.

Loudspeaker network which couples amplifier output to the two-way loudspeaker system. Design features selected parts to afford stability of operation under all conditions. Switches permit high or low-frequency speakers to be operated separately in the event of failure of any speaker unit.

Sound-head drive mechanism features cradle suspended oversize drive motor, flywheel, sight oil gauge, and flexible coupling of motor to gear mechanism, eliminating any mechanical vibration. Large oil-damped stabilizer drum of new and improved design.

Monitor loudspeaker employs a permanent magnet field speaker unit in a two-way baffle. The design is a definite step toward extension of the frequency response over that generally found in monitor speakers, resulting in more natural and pleasant reproduction.

The New SIMPLEX SOUND SYSTEM

A GRAPHIC STORY OF ITS MAIN FEATURES AND DESIGN

Main amplifier cabinet, enclosed type of sturdy three-section construction, designed for floor or wall mounting. Louvers on front and sides provide adequate ventilation. Front panel clips in place. Quickly and easily removed without the use of tools.

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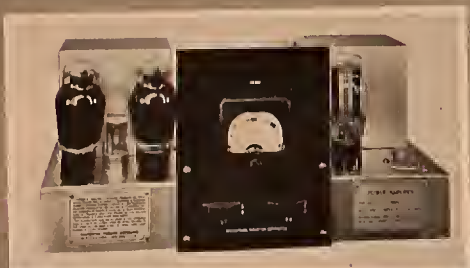

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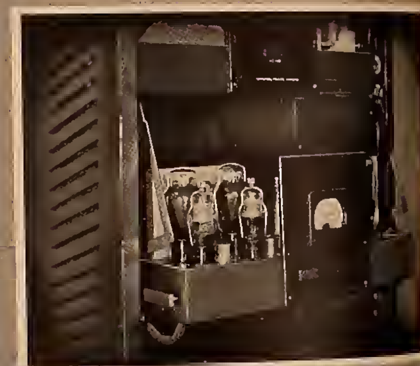

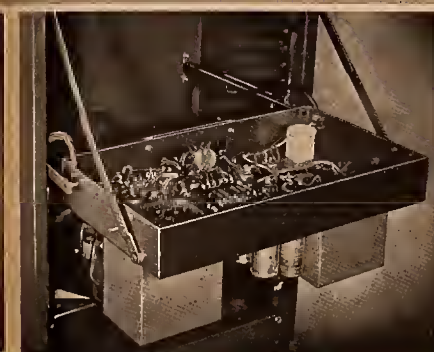

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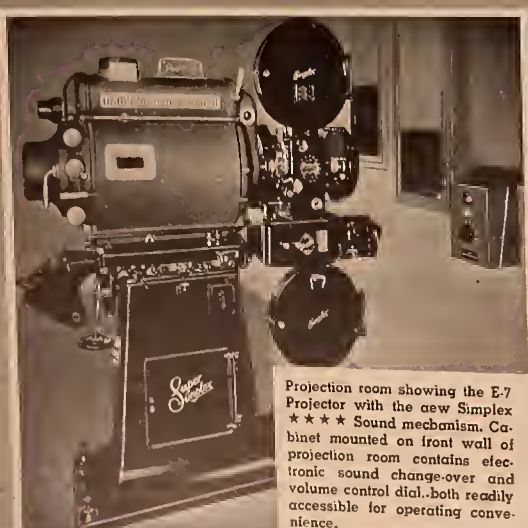

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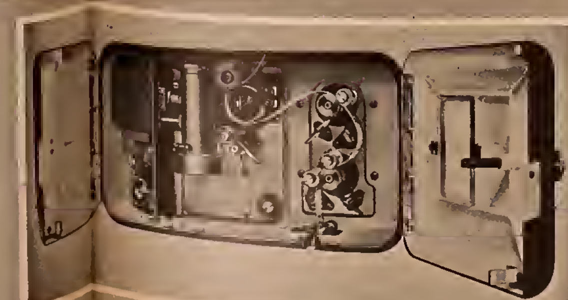


Monitor loudspeaker employs a permanent magnet field speaker unit in a two-way baffle. The design is a definite step toward extension of the frequency response over that generally found in monitor speakers, resulting in more natural and pleasant reproduction.

Analyses of Modern Theatre Sound Reproducing Units

By *AARON NADELL*

V. System Trouble-Shooting

CONSIDER Figure 1. Suppose the management reports noisy sound in the system it represents. Suppose the projectionist, turning up his monitor volume, is able to hear the same noise in the monitor. If he knows his Fig. 1 so thoroughly that mental reference to it is second nature with him, he knows also, without stopping to think about it, that the filter network and power amplifiers play no part in the difficulty and need no investigation.

This must be so, because the monitor amplifier branches off ahead of them. The noise can only be getting into the system at some point before the branch to the monitor is reached. This important conclusion, which reduces the time and effort needed to correct the trouble, is automatic and almost instinctive—if the projectionist really *knows* his Fig. 1.

Figure 1 is called a block schematic. The different pieces of apparatus are represented merely by outlines. Connecting cables are shown as *single* lines: it is important to note that each single connecting line in the diagram actually represents a *pair* of wires. The diagram is intentionally incomplete. Power line fusing and ground connections are purposely omitted; they will be dealt with later on in connection with Figs. 2 and 3.

Suppose that instead of noise the management reports complete sound outage, while the projectionist still can hear his monitor as well as ever. Fig. 1, ever in mind, locates the difficulty in less time than is needed to read this paragraph. He knows at once that his system is clear of trouble as far as the output of the voltage amplifier. The power amplifiers are not at fault, because they wouldn't both go bad at the same instant, and if only one continued to function, one band of frequencies still would be heard in the auditorium.

The same quick reasoning applies to the speakers themselves, so that only two possibilities remain. The speaker power supply rectifier (lower right of Fig. 1) is common to both stage speakers. It may have failed. Or there may be a fault in the speaker network input. No other component needs investigation.

The two possibilities can readily be reduced to one. If the power supply unit is responsible, very weak sound still will be heard by someone extremely close to the screen, because of the residual magnetism of the speaker cores. The management may be asked to check that point, if the projection room does not have (as it should) an ammeter in series with the speaker line. Assuming that the ammeter, or the report of the management, clears the speaker field power supply, the projectionist can proceed at once to look for the difficulty at the filter network input, with absolute assurance that he is examining the one and only section of apparatus that can possibly be at fault.

That is, so far as Fig. 1 is concerned. Fig. 2 introduces a slight qualification, to be explained hereafter.

At this point it is necessary first to note that mental reference to Fig. 1, however helpful, is obviously not enough, but must be supplemented by detailed knowledge which translates the outlines of that diagram into concrete, physical apparatus. Thus, suppose it was the power supply unit that proved faulty by the foregoing reasoning, the next question is—where is that unit? In the drawing it's at the lower left-hand corner, but in the projection room it may be any one of a row of three extremely similar-looking black boxes mounted somewhere along a wall. Cases are not unknown in which trouble, traced down as just described, has then been hunted in the wrong box!

Having located some probable causes of his difficulty by means of his mental block schematic, the projectionist must of course be able to identify the corresponding real apparatus with equal facility, equal lack of delay or confusion. A bit of preparation in the way of paint work is very helpful in that connection. White paint and large letters can be read from all parts of the projection room, and in a few weeks will become part of the projectionist's mental picture of his equipment. The projectionist should apply them at the same time that he provides himself with diagrams, similar to Figs. 1, 2 and 3, of his own, individual equipment. If there is any question of paint spoiling the appearance of the apparatus, water color may be used as assurance that every trace of the letter can be sponged away whenever required.

One other qualification applies to the use of Fig. 1. It is always possible that a given trouble is not located *inside* the unit to which it is traced but in one of that unit's connecting lines. Or if not in the lines themselves, then at the binding post or solder terminal where they complete their contact with the internal wiring. In all cases, a "unit" as shown in the diagram should

Test Your *Craftsmanship and Win Valuable Prizes in This Question and Answer Contest*

Appended to each article by Aaron Nadell are four questions for the best answers to which four awards are made each month. The Contest is open to any subscriber to I.P. who is engaged in practical projection work. Awards are made on one basis only—the best answers; manner of presentation counts for nothing. Also, the names of those whose answers average fifty per cent correct or better are published.

All answers must reach I. P. not later than the 1st of each month. The judges are Mr. Nadell and the editor of I. P. In case of a tie, identical awards are made. Prizes awarded include valuable accessories useful on or off the job. At the end of six months a grand prize will be awarded for the best single group of answers submitted during that period. Apart from the awards, the Contest is excellent practice and provides an excellent opportunity to test your knowldege of the art.

The questions this month deal with practical projection matters, as contrasted with previous questions which have dealt mostly with theory. This will enable the "practical" man to compete on even terms with the best of the theoreticians. Go to it!—*Editor.*

be understood to mean, as a matter of course, its external extensions in the form of connecting lines.

Consider the loud speaker supply line. It is diagrammed as running *directly* to the speakers, but this is hardly ever the case. In almost every installation it will run to some connection box or fuse block located backstage, and there contact the speaker cables. Point "A" of Fig. 1 will probably be inside that box. Trouble conditions which, as described, may indict the speaker field supply unit also automatically implicate its output cable as far as point "A" and, of course, its input power source back to the first fuse which it shares with other apparatus that is known to be working normally.

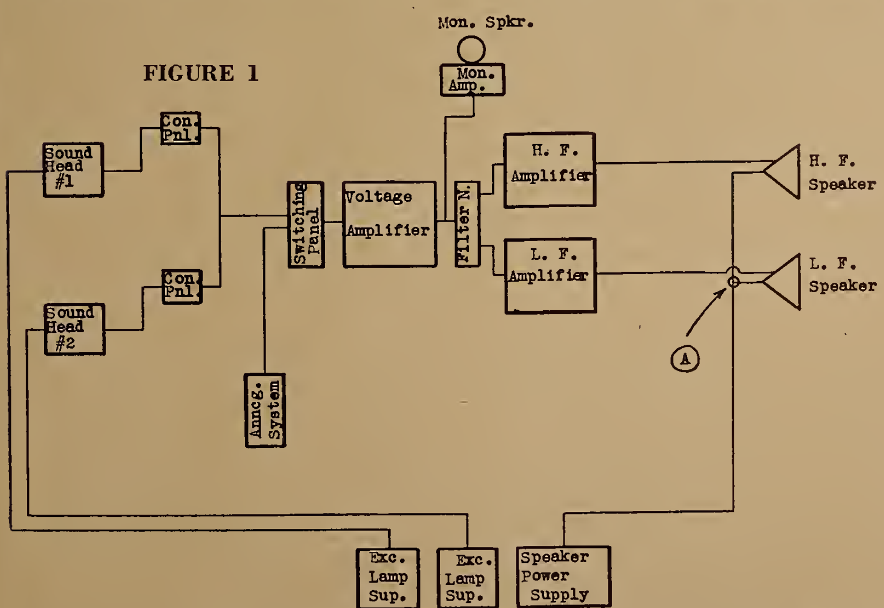
Similarly, a fault traced to the filter network input may not be inside that panel at all, but in the speech cable running to it—very possibly a ground at the point where the lead sheath was broken away from the rubber insulation to make connection possible: a sharp edge of lead may have pierced the rubber.

To sum up at this point:

(a). A block schematic, memorized in detail, takes a large part of the confusion out of trouble-shooting. It always eliminates some, and often a great part, of the total bulk of a sound system from further consideration, confining the possibilities of trouble to one or a very few sections of the equipment.

A man attempting sound repairs without having in mind a block schematic or its equivalent is about as badly handicapped as if he were to try to fix a projector without any clear idea about the difference between the upper feed sprocket and the intermittent sprocket.

FIGURE 1



(b). For the sake of simplicity, a system block schematic is commonly confined to system apparatus and wiring alone, but its maximum usefulness is attained only when block schematics of all grounds, and of all power sources and their fuses, have been added.

(c). The projectionist confronted with an emergency should be able instantly to identify any component of his mental block schematic with the corresponding physical component as it actually exists in his own projection room.

(d). Every unit of the block schematic should be understood to include input and output connections, and input and output wiring as far as the next point of junction—such as a fuse shared with other equipment, or point "A" in Fig. 1.

Vital Import of Figure 2

Proceeding now to Fig. 2, a vital point about that drawing is the way in which the same pair of fuses carry current for more than one piece of apparatus. This of course is not always the case, but is extremely common and surprisingly helpful. Thus, linking Figs. 1 and 2 as representing the same installation, it is obvious that if No. 1 exciter lamp supply rectifier fails to operate, the external fuse need not be inspected as long as No. 1 projector motor will run. If the fuse box is difficult of access, switching on No. 1 motor momentarily will save delay. Similarly, if No. 1 motor should stop while No. 1 exciter lamp continues lit, the first place to look for trouble is at the motor itself, or its switch—perhaps the foot switch, if there be one.

The circuits of Fig. 2 also qualify the use of Fig. 1. Referring again to the previous discussion, it was said that the power amplifiers would not both go bad at the same instant, and therefore needed no investigation. Fig. 2, however, suggests that the fuse which is common to both of them may have burned out, and that a glance at their filaments or signal lamps is therefore in order before anything further is done.

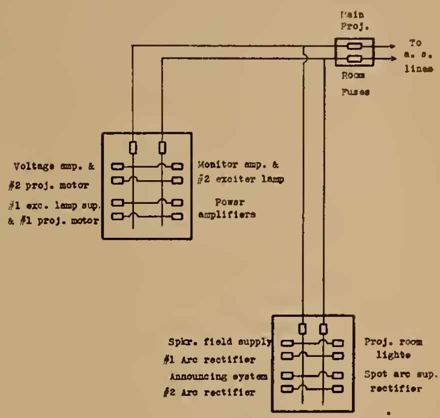


FIGURE 2

Or, assuming the trouble has been definitely traced to the speaker field supply rectifier, inspection of the fuse supplying that rectifier, if inconvenient because of the location of the fuse box, can perhaps be saved by striking No. 1 arc. If the arc lights, there is nothing wrong with the power supply to the speaker rectifier.

Fig. 2 shows up another extremely interesting possibility, one that would scarcely be suspected but for the existence of that diagram. Suppose a case of noisy sound appearing erratically when No. 2 projector is operated. Normal procedure might concentrate all work on No. 2 sound head, its control panel and connections, and fail to turn up the difficulty. A glance at Fig. 2 suggests at once that there may be some defective contact in No. 2 motor or its wiring which reacts through the power line to occasion noise into the voltage amplifier. That would be one of those common but "irregular" troubles that take a long time to run down, because it is what no one is likely to think of, and it will not be found by the usual processes of trouble-shooting. Cases of that kind add tremendously to the practical value of the diagrams here given.

Like Fig. 1, Fig. 2 is *incomplete.* The internal fusing of the separate items of apparatus should be added, and likewise the rating of all fuses in amperes. For example, suppose two items of apparatus which in Fig. 2 share a common fuse both stop working at the same instant. Considering Fig. 2 alone, it would be natural to suspect the common fuse, but if each of the two inoperative units is internally fused, it is quite possible that both internal fuses were burned out by a surge which the larger, common fuse was able to withstand. In that case, since the probabilities are equal, the point to be investigated first

is the one that will involve the least delay.

Fuse rating data is of course valuable in such cases, but not too reliable a guide, as every projectionist knows. There is no way really to test fuses without burning them out, and in consequence they do not always behave according to their ratings. Everyone knows cases in which a surge or overload left a small fuse unharmed and burned out a larger one in the same line. Trouble analysis which places unquestioned confidence in block schematic diagrams that are accurate for the system under consideration can never draw similarly absolute conclusions from fuse data. Knowledge of fuse ratings shows nothing more than the fair balance of probabilities.

A third block schematic of equal importance shows the electrical and (as far as possible) physical relations of all ground contacts. Grounds are a complicated and sometimes difficult subject, worth far more extensive treatment than is possible in an article dealing with the value of block schematics in finding trouble locations.

Figure 3, however, illustrates one common type of ground problem. In that drawing some a.c. wire, which may be inside or outside an amplifier or other sound unit, is in inductive relationship to a sensitive sound circuit. The induction is indicated by the phantom transformer drawn in dotted lines: if the induction were static, a phantom condenser would take the place of the transformer; or both types of induction might exist simultaneously.

Now, it is obvious from Fig. 3 that if both grounds are at exactly the same potential (both very thoroughly bonded to earth) the secondary of the phantom transformer will be short-circuited. and no hum will be picked up. But if there is any appreciable resistance in the ground clamps (or if the two ground connections are linked by corroded water pipes) current will flow through the unintended resistance by reason of the potential difference induced. A parallel branch for that current may be traced from the right side of the phantom secondary up through the amplifier input transformer, left, down through the sound head output transformer, and back again to the phantom secondary. In other words, part of the induced a.c. hum will flow through the sound input.

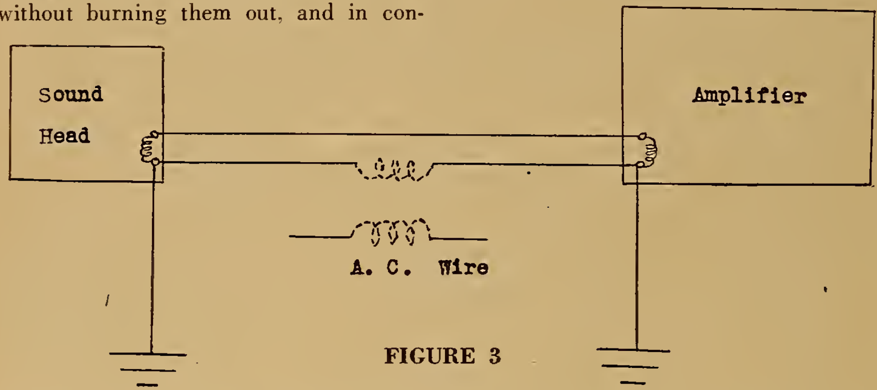


FIGURE 3

This condition can appear without warning, as a result of corrosion at any point which is intended to link the two grounds shown to a common or "earth" potential. The remedy is either cleaning or tightening the ground connections, or bonding them firmly with wire heavy enough to form an effective short-circuit—that is, to by-pass so much of the hum that what is left in the sound circuit is not enough to be heard.

Simple as that remedy may seem by reference to Fig. 3, it is usually complicated in practice because of doubt as to the physical location of the grounds in question. The sound head is often grounded only to the projector base, which in turn is somehow grounded to earth, but not all projectionists know where to find the earth connection of their projectors.

The sound amplifier, on the other hand, although connected to the projector through conduit or other shielding, (forming a comparatively high resistance conductor) will have a separate ground to a water pipe, and not all projectionists know where that is located. Hence there is usually considerable confusion as to what the real ground relations are, and few projectionists could draw off-hand an accurate duplicate of Fig. 3 as applied to their own equipment, or give much useful data to a sound engineer seeking to cure a hum.

Fast trouble-shooting calls for an exact representation of Fig. 3, applied to the entire sound system, and particularly including all pipe, conduit or flexible shielding taking part in the earth connections. The physical location of every ground clamp attached to a water pipe or other indirect "earth" should also be noted, with such detailed geographical information as will make possible finding and inspecting it at moment's notice.

Finally, the three diagrams, although relating to a single system, should be drawn separately and kept in mind as separate, individual arrangements. The attempt to combine them often leads to a degree of forgetfulness or mental confusion, whereas treated separately they are easily remembered and just as useful in time of emergency.

These Contest Answers Were The Best

NO SINGLE contestant submitted a group of answers that merited publication in their entirety as satisfactory replies to the third group of questions. Thus, the best answer to each of the four questions was selected from the papers of as many contestants; while the winner of the first award was decided upon the basis of the best ranking overall.

This situation is one of the strange aspects of the Contest, although the theoretical nature of the questions to date may account in some measure for the wide divergence in markings scored by a given contestant on all four questions. The winner, Don Howard, turned in a paper typical of all the others—two high-ranking answers, one fair and one poor answer; yet his overall ranking sufficed to win. Two of the published answers come from contestants who did not rank among the first four—Messrs. Ellison and Borgeson; but these gentlemen, in turn, tied with three others. This circumstance obviously dictates the award of consolation prizes to all five men; and this will be done.

The best answer to each question is appended hereto.

9. If one tube in a full-wave pair supplying speaker field windings has aged to the point where its partner is doing practically all the work, what may be the result to the sound?

By *DON HOWARD*

A. Where speaker fields are supplied current from a full-wave pair of tubes, independent amplifier and exciter lamps. Results to sound output are as follows:

1. The sound level is usually reduced by more than one-half volume.
2. Some distortion is present. Noticeable on reproduction of lower frequencies, caused by insufficient field flux density to stabilize the voice coil.
3. The natural tendency is to raise the fader and gain control to overcome sound attenuation, which is a dangerous procedure, especially where considerable power is available in the output stage. Excess current is fed into the speaker voice coils and in great amounts should the amplifiers be taxed to point of overload. Speaker voice coils which are wound with delicately small wire, (the W. E. 555 reproducer is a good example) one or more of the coils are almost certain to burn out, the result being additional or complete loss of sound.
4. Some field supplies present additional troubles: sufficient filtering is employed to satisfactorily smooth 120-cycle pulsating current, but not for 60-cycle ripple. So long as the faulty tube passes a small amount of current, 120-cycle ripple will

CONTEST WINNERS

(February Issue Questions)

First Award

DON HOWARD

Strand Theatre, Rawlins, Wyoming

Second Award

THEODORE P. HOVER

Secretary, L. U. 349, Lima, Ohio

Third Award

H. D. TAYLOR

705 W. South St., Raleigh, N. C.

Fourth Award

W. FENWICK

Capitol Thea., Victoria, B. C., Can.

Consolation Awards

go to the following men: L. G. Borgeson and T. Morisawa, both of Los Angeles, Calif.; C. E. Mervine, Pottsville, Pa.; Chester A. Ellison, Reading, Mass., and Ray Mowery, Mahanoy City, Pa.

enter the filter system and be filtered; the greater impressions, however, are at 60 cycles. The result is a 60-cycle note or hum emitted from the speaker diaphragms.

B. Where speaker fields are excited by a full-wave pair of tubes supplying amplifier filaments and exciter lamps:

1. Total loss of sound usually results, as tube filaments and exciter lamps are deprived of the greater portion of their current, as are the speaker fields.

2. Conditions cited under A, sections 2, 3, and 4, do not apply in this case.

C. Where speaker fields are an integral part of the amplifier filter system, or are connected to the amplifier filter, but not dependent thereon for filter action:

1. Reduction of sound would ensue not only by reason of lowered field potential but also through lowered outputs of all amplifier stages, because of the B supply voltage-drop.

2. Conditions cited under A, section 2 exist and, in some cases, section 4; section 3 thereof does not apply.

10. How can sound wave-length be found when the frequency is known? Could a test sound of 400 cycles be reflected as echo from a ceiling broken up into recesses four feet square?

By *THEODORE P. HOVER*

Since sound travels approximately 1100 feet per second and the frequency or number of waves per second is given, it will be seen that the number of waves per second will be equally spaced over a distance of 1100 feet. Therefore, the length of each wave will be its fractional part of the total distance traveled in one second, namely, 1100 feet. The test sound of 400 cycles would have a wave-length of approximately 2.75 feet.

It would appear that it could be reflected as an echo from a ceiling broken up into recesses four feet square. It seems to me that the depth and form of these recesses would have considerable effect in this problem.

11. Raspy sound heard in the theatre is not heard with headphones connected across the speaker line in the projection room? What may be suspected?

By *CHESTER A. ELLISON*

Raspy sound coming from the stage speakers and not heard in the transmission line from the amplifier to the speakers may be caused by:

1. Loose or torn cone on a speaker. 2. Loose "spider" set screw, or "spider" coming loose from the cone. 3. Dirt in speaker between pole pieces and voice coil. 4. Speaker loose on baffle or horn. 5. Voice coil out of alignment and rubbing on pole pieces.

6. Sympathetic vibrations in something on or near the stage, which is resonant at a certain frequency and vibrates, causing annoying distortion. 7. Overloaded speakers. 8. Defective coupling network—line to speaker. 9. Loose connection to voice coil or field. 10. Open voice coil or field, if more than one speaker, causing impedance mis-match to other speakers.

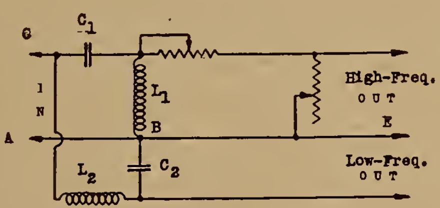
12. What trouble in Fig. 3 could cause drastic loss of high-frequency volume? Of low-frequency volume? Of both?

By *L. G. BORGESON*

It is assumed that the speaker units are o.k. at all times. The accompanying diagram represents a parallel-type network. Since nothing is stated concerning cross-over frequency or the rate of attenuation, the values of the capacitors and inductances is unknown. However, the value of C_2 is greater than C_1, and the value of L_2 is greater than L_1 in this type of network.

A. *Drastic* loss of high-frequency volume may be due to:

1. Open circuit at any point in the high-



frequency circuit ABEC, due to broken wires, loose connections, *etc.*

2. L_1 "shorts" out. The resistance of the "short" must be low, *i. e.*, lower than the high-frequency speaker impedance for

DESCRIPTION OF AWARDS TO CONTEST WINNERS

So popular were the awards granted last month that it was decided to repeat them, as follows:

***First Award* (Howard): A Packard Lifetime Lektro-Shaver contained in a handsome leather carrying case.**

***Second Award* (Hover): A Simplex volt-ohm meter of pocket size. Voltage ranges: 0-3, 0-30 and 0-300 d.c.; resistance range: 0-10,000 ohms. Magnetic vane type meter. Walnut bakelite case.**

***Third Award* (Taylor): A copy of "Radio Physics Course," 2nd Edition, by Alfred A. Ghirardi. 972 pages. 6½ x 9, 510 illustrations, beautifully bound and completely indexed.**

***Fourth Award* (W. Fenwick): A new type Radio Slide Rule for rapidly determining (1) capacitative reactance when capacity and frequency are known, (2) inductive reactance when inductance and frequency are known, and (3) resonant frequency when capacity and inductance are known.**

***Consolation Awards* (Messrs. Borgeson, Morisawa, Mervine, Ellison and Mowery): Each will receive a Test-O-Lite, considered the handiest electrical tester on the market.**

drastic loss of volume. A "dead short" will render inoperative the high-frequency speakers.

3. L_1 "shorts" out. Result: loss of highs. The amount of loss depends upon the relative values of C_1 and C_2. The higher the ratio of $\frac{C_2}{C_1}$, the greater will be the loss. Since C_2 is greater than C_1, the impedance through the high-frequency circuit is greater than the impedance through C_2, so there will be considerable loss of high-frequency volume.

4. If C_1 open-circuits in some manner, high-frequency volume will be lost entirely.

5. Defective L-pad causing a "short" between the two sides of the line.

B. *Drastic* loss of low-frequency volume

Here are the Contest Questions—

NOTE:* *Answers should be predicated on the diagrams accompanying this article and not on contestants' own equipment.

17. Sound stops with No. 2 projector in operation. A glance at all tubes and exciting lamps in the projection room shows every filament lit normally except No. 2 exciter lamp. A new lamp installed in No. 2 fails to light. What would you do to restore the show in the fastest possible time?

18. A preliminary check in the morning shows no sound, either in stage or monitor speakers. Tests show system is unresponsive to input from either projector. State the possibilities in the order in which you would check them for quickest results.

19. The management reports hum in the low-frequency speakers only. Disregarding ground troubles, state the procedure you would follow.

20. Sound is weak in the high-frequency speaker. What procedure would you follow to restore normal quality and volume with the least possible delay?

[*In answering these questions, disregard the* details *of any work done* inside *the units diagrammed: state only which unit would be investigated, and what condition or conditions would be sought therein.*]

might be due to any of the following:

1. L_2 open-circuits. No lows will be reproduced.

2. C_1 punctures *i. e.*, short-circuits. Part of the lows will be shunted through L_1. The amount of volume loss will depend upon the relative values of the inductances L_1 and L_2. The lower the ratio of $\frac{L_1}{L_2}$ the greater will be the low-frequency volume loss. Since L_2 is greater than L_1, the impedance through the low-frequency speaker circuit is greater than the impedance through L_1, so there will be a considerable loss of low-frequency volume.

3. C_2 punctures, *i. e.*, short-circuits. The resistance of the "short" must be low for drastic loss of low-frequency volume. If there is a "dead short" through the condenser, the low-frequency horns will cease to operate.

4. Open circuit anywhere in the low-frequency circuit.

C. Drastic loss of both high- and low-frequency volume may be due to:

1. Open circuit in common lead AB in accompanying diagram. All speakers will be dead.

2. Open circuit between BE. Volume will be down on both high- and low-frequency speakers.

3. Short-circuit between A and C.

4. C_1 shorts and L_1 shorts effect of the resistance of the short the same as above.

5. C_1 shorts and L_2 shorts. 6. L_1 shorts and C_2 shorts. 7. C_2 shorts and L_2 shorts. 8. C_1 open-circuits and L_2 open-circuits.

9. Open circuit in the wiring of both the high- and the low-frequency parts of the circuit.

Among those who submitted papers averaging fifty percent correct or better were the following, not listed here in their order of ranking:

James A. Day, Detroit, Mich.; G. H. Payne, Westerly, R. I.; Lester W. Shaffer, Shrewsbury, Pa.; Ray Bartzer, Sheboygan, Wisc.; Carl Rossi, Brooklyn, N. Y.; Clyde Richards. Corvallis, Ore.; Leo Cimikoski, Norwich, Conn.; Frank Swalbert, Buffalo, N. Y.; Andrew Pura, St. Thomas, Ont., Canada; Harold LeRoy, Cortland, N. Y.

Also, Walter Fink, Mahanoy City, Pa.; Walter Pyle, Assiniboia, Sask., Canada; Roy Arnston, Minneapolis, Minn.; Lauriat Du Four, So. Portland, Me.; J. T. Kirkham, Calgary, Alb., Canada; Haynes Howell, Roswell, N. Mex.; Phil Martin, Jr., Washington, D. C.; R. A. Young, Homestead, Fla., and John L. Stauffer, Steubenville, Ohio.

Technical Data on the Simplex Sound System

(*Continued from page* 17)

for low-frequency response. High and low frequency speakers of the very latest and high fidelity response design form part of all installations regardless of size of theatre.

The entire system is designed to employ a minimum number of standard metal or glass types of tubes, universally obtainable. Metal 6J7 types were selected for inherent shielding and freedom from microphonic tendencies. Glass 6L6 tubes were selected for uniformity and improved performance. Tube types in use: 6J7, driver stage; 6J7, phase inversion stage; 2 6L6G tubes in push-pull power output stage; and a 5Z3 full-wave rectifier.

Overall the Simplex Sound System is of compact and sturdy construction which requires a minimum of space, simplifies installation and provides for easy, quick and economical servicing. All parts on special mountings are easily removable to facilitate servicing.

The power transformer mounted on the amplifier chassis is tapped to compensate for various line voltages of 105, 115 and 125 volts. It is oversize to render continuous service on 50 or 60 cycles.

Amplifier frequency characteristics meet Academy of M. P. Arts and Sciences recommendations. Warping adjustments are provided which permit four variations in the low-frequency and four variations in the high-frequency response characteristics, in order to match various loudspeaker combinations.

Dual amplifier switching facilities (when provided) permit isolation of defective amplifier (where more than one is used) from the signal circuit without disconnecting from power supply. This facilitates servicing which may be carried on, if desired, while show is on.

Electronic sound changeover comprises a three-way switching arrangement, one at each projector station, to control bias of second stage of volume control amplifier. This method of changeover control is instantaneous and noiseless, since it avoids the necessity of breaking the signal circuit. Switching may be made at either projector. The exciter lamp circuit is simultaneously transferred in the changeover operation.

To sum up, the combination of these advanced engineering ideas make for a sound system which reproduces sound of such high quality, it seemed to the writer, as to be a delight to listen to.

—J. J. F.

COLOR FILM, SOUND FEATURE S.M.P.E. PAPERS PROGRAM

(*Continued from page* 12)

film would occasion many changes in both the production and projection processes.

International Projector Corp. presented papers on two new equipments, the Simplex E-7 projector and the Simplex sound system (the latter being described in detail on pages 18 and 19 herein).

Three sessions were devoted to sound in all of its phases, and there were complete sessions devoted to papers dealing with developments in photographic and laboratory processes, optics and projection developments, 16 mm. equipment, new apparatus, and educational and industrial motion pictures.

Those papers of particular interest to projectionists will be published in these pages from time to time. A partial list of abstracts is appended hereto:

MOTION PICTURE PROJECTION FROM METALLIC FILM

R. W. Carter

Taylor-Sloane Corp.

A brief history is given of the various processes for putting photographic images on metallic surfaces and the evolution from flat surfaces to flexible metal ribbons is discussed. The subject of metal films is traced under the following headings: The physical and mechanical difficulties in the development of a metal strip suitable for projection. The physical, chemical, and mechanical properties necessary for the photographic emulsions and photographic developers. The effect of mechanical strain and the heat of the projection machine upon the metal film. The relative wearing quality of metal film as compared with that of cellulose film. The possibilities of coating both sides of the metal strip and the development of printing machines to print thereon.

Also, making original master negatives on standard photographing equipment. Dubbing positive prints from the master metal negative. The optical system best adapted for getting the highest possible reflection

(*Continued on page* 29)

Print Trials and Tribulations on the Small-Theatre Front

WE HAVE three changes weekly, and on every print we receive all splices must be remade. It requires an hour's work to remake the splices and patch broken perforations on one double reel. The fellows in the big theatres know little about this because usually they get new prints. (*Page Mr. Barrows.—Ed.*) Recently we ran a double reel that had about 90 splices, all of which had to be remade. Our chief, Arthur Boyer, gave up trying to count these splices after losing count on his twelfth attempt.

Exchange cement must be made of sugar and water. They should be billed for labor and cement incident to patching their trash. They consider 5 frames per patch a marathon distance. Skipping inspection would mean a stop every 5 minutes in our theatre. I'm beginning to think that exchanges pick out kind-hearted theatres like ours to patch their film, because they know that when it leaves here it can run in any theatre in the world. (*Why not refuse a few prints? —Ed.*) Improper rewinding and packing in cases is the major cause of torn perforations.—WARREN STIELY, Midland Theatre, Valley View, Pa.

Practical Hints on Servicing and Replacing Theatre Sound Installations

By *J. A. COOK*

CHIEF ENGINEER, COOPERATIVE SOUND SERVICE CO.; MEMBER, L. U. 143

WHEN an independent servicing company starts into business, particularly in the face of keen competition by a national servicing organization, its engineers are immediately confronted with several important questions:

1. What would happen if an indispensable transformer failed in the center of an amplification system on a Saturday night and there happened to be no spare closer than 200 miles?

2. What would happen if a failure occurred in an obscure place in a system with which the service engineer was not familiar, or on which the manufacturer does not furnish information?

3. What would happen if a complete system were replaced by one manufacturer by another manufacturer, and after making the "cut-over" it was found that the new system had some obscure defect that could not be cleared before show time? (Here it is understood that the house is not dark.)

4. What would happen if an engineer were assigned on installation of a totally new type of equipment and adequate drawings and specifications were not available?

Requisites of the Situation

In 1936, with an independent service company, I was confronted with these same questions; and, needless to say, our competitors saw to it that exhibitors had the same thoughts. There was only one solution to the problem: to break all records for time in clearing troubles, without a single exception and without alibis or excuses.

During the first month the market was combed for a high-gain, high-power, rubbed, lightweight amplifier employing Class A amplification with low harmonic content and negligible volume distortion. In September, 1936, we found a suitable P. A. amplifier which met with all of our toleration limits. This amplifier had two microphone and one disc pickup inputs, but had no photoelectric cell inputs. This amplifier was complete within itself, by which is meant that horn fields were not a necessary part of the amplifier. However, from one to four 1000-ohm, 100 ma. fields can be carried by the amplifier without making internal changes.

Among the first to recognize the value of organization servicing work, the St. Louis independent group, backed by the Local Union, still services 70 theatres. This situation reflects the organizing and technical ability of the author of the accompanying service notes, which are based on practical experience over a long period of time rather than on any theoretical approach to the problem.

Our next step was to develop filter and voltage networks for installation in the amplifier to so match-in photoelectric cell inputs that the amplifier would become a complete compact amplification system (including silent changeover) from film sound tracks, disc pickup *and* ribbon microphone to 500-, 16-, 8-, or 4-ohm horn net works. After about eight weeks of intensive work in the laboratory, this job was completed.

The result was a 23-pound portable amplifier embodying two photoelectric cells, six amplification tubes and one rectifier tube. The microphone and disc pickup inputs were retained. It finally included everything required in an amplification system. It replaced photoelectric cells, head amplifiers, fader, attentuators, film-disc transfers, main amplifiers and the 90-volt "B" supply. These units are extremely fast and sure for use during emergencies and are exceptionally good for continuous use.

Clearing Trouble Speedily

When an engineer cannot clear trouble in the regular theatre system in less than four minutes in any case of emergency, one of the standard interchangeable units is merely plugged in with four plugs and three clips, and the show goes on. Any auditorium or arena up to 6,000 seats can easily be carried with proper horns. The trouble in the regular system is then cleared at the engineer's convenience, or when replacements are received.

When an equipment is replaced by another of a different type or make, all old equipment and conduit in the projection room is removed during the first two hours of work. In another three hours the two new machines are set up, together with the portable amplification system and power units, and the regular show can proceed without interruption. It usually requires four days to replace old equipment and conduit with new. As the portable equipment is not in the way of the new conduit the electricians are given an opportunity to make an excellent installation. There is then no excuse for an installation having a sloppy appearance and poor electrical connections.

Being protected against any electrical failure which might "lose" the show, we next turned to the mechanical problems involved. This hurdle was easily surmounted, as many obsolete installations were replaced with modern jobs. Some of the latter are set up in storage exactly, as they would be in a theatre. When a needed part or unit is used, it is immediately replaced.

It might be well to mention here that at various periods during a "modernizing" installation an engineer's time is worth over $200 per hour. I have reference here to the few extra minutes it requires to protect good glassware, lens assemblies and such items against breakage, and the protection against misplacement, misappropriation, or other loss of special bolts, adapters, shafts, gears, screws, *etc.*

Many engineers like to put all special parts in boxes, which procedure is absolutely wrong. The parts get spilled, lost, misplaced and usually transferred with the wrong equipment, in case the exhibitor has a chain of houses. All bolts and screws should be screwed back into their original holes and other small parts securely tied in their associated larger parts.

High Cost of Carelessness

In handling circuit theatres we found that enormous waste results on account of good equipment removed being dismantled and parts used in other theatres for repairs. For example: theatre A has 1,000 seats and replaces its good low-intensity lamps with Suprex lamps. Theatre B has similar low-intensity lamps, on which a feed motor begins to spark, but not seriously. The commutator merely needs turning down.

An armature is taken from one of the spares in theatre A. All parts removed to get the armature out are finally scattered and lost; and the armature with

the sparking commutator in theatre B is left in a back room in that theatre. The once good lamp, now incomplete, is transferred from theatre A to the warehouse.

A few months later theatre R needs a pair of low-intensity lamps such as were removed from theatre A. One of the lamps from Theatre A is beyond reasonable repair. The business at theatre R does not warrant the expense for a pair of new lamps, so they continue with the obsolete crippled pair available, hoping that some other theatre with a modern pair of low-intensity lamps will install new Suprex and relinquish their lamps.

If a few minutes more had been used to return the armature with the sparking commutator from theatre B to theatre A and to install it with all of the other parts removed, the lamp could have been reinstalled in Theatre R with a new 10¼″ reflector as an economical major improvement.

The foregoing example hardly applies to independents, as they usually trade-in. Moreover, they indulge in a different form of waste. If Emerson were writing his "Twelve Principles of Efficiency" today, in connection with exhibitors he probably would state that independents had to exercise "cooperation," while chains had to exercise "discipline."

Finally, and very important, is a system of records. Equipment records, service, and condition reports should be as brief as possible but still reflect all the facts. Every one concerned should get a copy of each report, addendum, or supplement. When records are not complete, brief and clear, many hours are wasted on the 'phone and in conferences. Material is sometimes not ordered, or may be ordered in duplicate, or orders may be delayed. With proper record systems the human element of error is eliminated. If such errors can be made the report and record system is wrong and should be analyzed by someone experienced in shop routine methods.

While service is mainly an assurance of continuity and quality of sound, a service organization can contribute much to a better show and at the same time save the exhibitor money. It is up to the service company's organizing, technical methods, and planning personnel together with the backing in instruments, equipment and emergency supplies. It can be done; it *has* been done.

THE VARIAC: A FLEXIBLE AND EFFICIENT DIMMING CONTROL

By **ENGINEERING DEPARTMENT, GENERAL RADIO CO.**

ILLUMINATION control and the dimming of lights, associated in the popular mind with the professional theatre, have a number of other applications as well. The amateur stage, churches, small concert groups and window displays all present much the same lighting problem. For these, the expensive resistance-type dimmers used in the theatre are impractical, not only because of their initial cost, but also because they are wasteful of power and generate a corresponding amount of heat. The lighting control system is therefore usually "hand-tailored" for the job.

A recently developed a.c. voltage control, the Variac, has been widely used in these systems. A control of this type can be used only on a.c. circuits, but since most amateur and temporary installations are in a.c. districts, this is not a serious limitation.

As shown in Fig. 1, the Variac is small and compact. It actually handles more power for its size than any other type of control, which explains, in part at least, its popularity.

Practically No Power Loss

Electrically, it is an autotransformer and consists of a single layer of enamel-covered copper wire wound on a ring-shaped iron core. A carbon brush makes contact with a strip along the winding where the insulation is removed, and effectively "taps off" a portion of the total voltage. This is shown in Fig. 2. The position of the brush

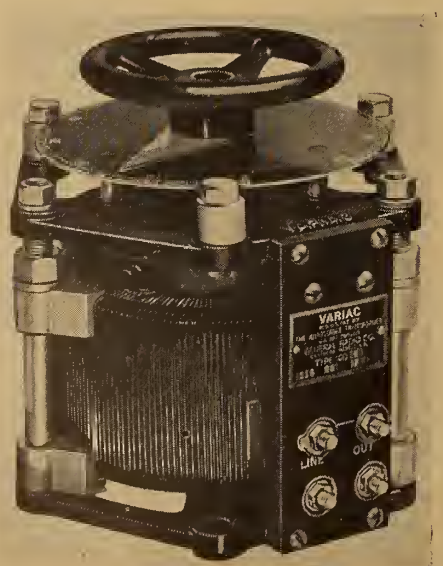
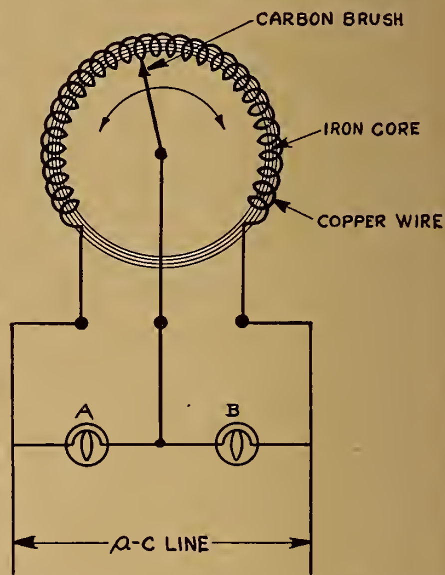


FIGURE 1

is controlled manually, and thus any voltage between zero and full line voltage can be obtained. A simple rotation of the knob covers the entire range.

Since this control unit is a transformer rather than a series resistance,



there is practically no power loss, and the output voltage is entirely independent of the load, within the limits of the Variac rating.

Function as Dimmer Simple

The function of the Variac as a dimming control is simple. If a set of lights are connected between the carbon brush and one side of the line, as shown at A in Fig. 2, the voltage applied to the lights decreases as the brush is rotated to the left and increases for a rotation to the right. Connecting two banks of lamps as shown at A and B, Fig. 2, allows one set to be faded out while the other is brought up.

Variacs are available in several sizes between 750 watts and 2 kilowatts. Mounted models, fitted with standard plug connectors can be used on the floor or table for temporary circuits. Unmounted models are available for building into permanent control boards.

I. A. CONVENTION TO CLEVELAND

The next convention of the International Alliance will be held in Cleveland, Ohio, June 5-9. Officers' terms having been extended to four years at the last convention, the forthcoming meeting will be able to devote its entire time to what is expected will be a heavy business schedule, the result of extensive I. A. activity within the past two years.

COLOR FILM, SOUND FEATURE S.M.P.E. PAPERS PROGRAM

(*Continued from page* 26)

from the polished surface of the metal film. The comparison of light transmission from celluloid and metal films. The effect of heat upon the image on a metal film. Can a metal film be joined rapidly if it comes apart? A comparison of shrinkage between metal film and cellulose film. What evidence have we of the permanence of metal film? Will it be possible to develop color on metal film, and will the use of prisms make it possible for successful projection?

Also what changes will the projectionist have to make in technic and general practice? Why will the sound be more accurate from a reflected image? Will it be possible in the future to use a series of sound-tracks in various languages on the metal film? With the elimination of the fire hazard, shrinkage, and the introduction of less weight and positive permanence, what are the chief defects to be expected in metal film, and what is proposed to overcome these defects?

PROGRESS COMMITTEE REPORT

J. G. Frayne, *Chairman*

The outstanding event in cinematography during the past year was the development of the high-speed panchromatic emulsions by Agfa Ansco. Other interesting advances in the emulsion field are two fine-grain duplicating film stocks by Eastman. Of interest also is the new sound emulsion by Dupont in which the periodic variation in sensitivity brought about by the present emulsion-drying methods has been eliminated.

TRANSMITTING MOTION PICTURES OVER A COAXIAL CABLE

H. E. Ives

Bell Telephone Laboratories

The transmission of television signals over wire lines a number of years ago used signals corresponding to images of coarse detail, and required frequency bands accommodated by existing types of circuits. The television images now considered necessary correspond to frequency bands of greatly increased width, and will require special wire networks and transmission means.

The coaxial conductor recently in operation for experimental purposes between New York and Philadelphia can transmit a band of frequencies of approximately 1000 kc. While designed primarily for multiple telephone channels, it offered the possibility of transmitting a single wide band as required for television.

The experiment consisted in providing television-type terminal apparatus for producing signals falling within the available band, and of developing and utilizing methods of transmission that would make most complete use of the frequency band available. For convenience in the experimental work, the signals were generated from motion picture film. The film was scanned mechanically by means of a lens disk containing 240 lenses. The film was moved continuously at 24 frames per second, and its motion, together with the motion of the lenses in the disk, swept each frame of the film in 240 juxtaposed lines. Light passing through the film was received on a photosensitive surface; the resulting photoelectric current was amplified and, by means of modulating and demodulating apparatus, transmitted as a single sideband lying between approximately 150 and 950 kc. At the receiving end the single sideband signal was restored as a signal from zero to 800 kc.

For reception, special cathode-ray tubes were used in which particular attention was paid to the definition of the spot and the linearity of response. Synchronism between the two ends was obtained by sending a single frequency over a separate channel and using it to operate sweep circuits at the receiving end. The use of mechanical scanning and the high-definition receiving tubes resulted in pictures of very satisfactory quality within the limitations set by the frequency band. (Illustrated with slides and motion pictures.)

INTER-RELATIONSHIP OF THE VARIOUS ASPECTS OF COLOR

Loyd A. Jones

Kodak Research Laboratories

An understanding of the subject of color and color measurement involves a knowledge of many and diverse phenomena, leading into many fields of physical or objective science, such as physics, physiology, biology, chemistry, *etc.*, as well as into the domain of a subjective science, psychology.

The present treatment of the subject is designed largely as a means of establishing orientations in the general field. An attempt is made to develop a logical and unambiguous nomenclature that will enable us to discuss various aspects of the subject without the confusion that exists so

generally at the present time when individuals of diverse trainings and viewpoints attempt to discuss the subject of color. The subject-matter divides itself rather logically into three clear-cut categories, which may be referred to as the physical, psychophysical, and psychological. Attention is drawn to the relation existing between the correlated aspects in each of these three categories. An attempt is made to clarify the purely physical factors involved and to discuss certain sensory and perceptual aspects of color and the relations existing between them and their physical and psychophysical correlates.

STANDARDS COMMITTEE REPORT

E. K. Carver, *Chairman*

The tentative drawings that have received initial and final approval by the Standards Committee have been published in the March issue of the JOURNAL. The uncompleted items at present under consideration are:

(1) Drawings for standard cores for cine film.

(2) Further consideration of the proper separation distance between the two halves of the push-pull sound-track.

(3) Drawings of sprockets for 16-mm. sound-film.

(4) Revision of the standard release print to correspond with the revisions made by the Academy.

(5) Review and possible revision of the glossary of technical terms.

(6) Carrying out actual tests on the new sprocket perforation for 35-mm. film, which, it is hoped, will displace the old Bell & Howell perforation.

DETERMINING THE SCANNING LOSS IN SOUND OPTICAL SYSTEMS

E. D. Cook
General Electric Co.
V. C. Hall
Eastman Kodak Co.

The usual methods of evaluating the frequency characteristic of sound records have been satisfactory for the determination of the required correction for overall losses. However, the losses due to aperture and optical effects are not known with sufficient precision to permit an inferior limit to be assigned to film loss only.

The method described was chosen in connection with a high-fidelity development, and consists in comparing direct measurements made on images formed by contact printing of a geometrically shaped test-object on the film with measurements of frequency records made using the recorder optical system. While the results obtained can not be applied generally, the method is capable of segregating film loss from other losses for the specific conditions under which the test is conducted.

THEORY OF COLOR REPRODUCTION

A. C. Hardy
Massachusetts Institute of Technology

All methods of three-color photography are the outgrowth of a suggestion made in 1855 by Clerk Maxwell. The method that he suggested would now be classed as an additive process, since the final reproduction was effected by projecting three lantern-slides in register on the same screen; one lantern being supplied with a red filter, one with a green filter, and one with a blue filter. Maxwell suggested further that these lantern-slides be prepared from three negatives, each negative being exposed through the same filter that was to be used in projecting the corresponding lantern-slide. An extension of Maxwell's reasoning to subtractive processes leads to the conclusion that the dyes used in the production of the positive images should each be complementary in color to the corresponding taking filter.

Despite Maxwell's intimation that his process was theoretically incapable of perfect reproduction, the basic features of Maxwell's reasoning have been incorporated into the commonly accepted theory of color reproduction. The recent progress in the science of colorimetry has made it possible to investigate the relation that should obtain between the characteristics of the taking filters and the colors of the reproduction primaries. Such an investigation shows that the taking filters required for perfect reproduction have characteristics that are very different from those in common use.

The paper is concerned with the establish-

ment of the conditions that lead to faithful reproduction by any three-color process. Examples of the application of these fundamental conditions are given for both additive and subtractive processes.

PUSH-PULL RECORDING WITH THE LIGHT-VALVE

J. G. Frayne and H. C. Silent

Electrical Research Products, Inc.

Push-pull recording on film is accomplished by means of a double light-valve having four ribbons. Distortions introduced by the recording medium which are represented by second-order harmonics balance out in reproducing, as do also the frequencies introduced by the action of the noise-reduction system. As a result, push-pull recording not only eliminates certain defects of conventional recording, but permits the application of new technics that allow further extension of the volume range and improvement in the naturalness in the final product.

DESIGN AND OPERATION OF THEATRE LOUD SPEAKER SYSTEMS

J. F. Blackburn

Lansing Manufacturing Co.

Although really satisfactory loud speakers have been commercially available for only a comparatively short time, all the essential elements of a good loud speaker have been at hand for many years, so that the reasons for the late appearance of suitable units must be sought in the economic rather than the technical field.

The loud speaker with its horn and other adjuncts is considered analogous to the antenna and plate circuits of a radio transmitter. It is pointed out that probably only in acoustics and in radio transmission do we have to be so wavelength-conscious, since only in these cases do the wavelengths of interest range from very small to very large, compared with apparatus dimensions. This wide range at once denies the use of the types of simplifying assumptions that are so convenient in other fields, and introduces several sets of mutually contradictory requirements for the apparatus. To date, apparently no one has succeeded in fulfilling all these requirements in a single piece of apparatus, so that it becomes necessary to use multi-channel systems with appropriate frequency-dividing networks.

One solution to the requirements just outlined is discussed in detail from the engineering point of view. The comparatively meager published design data are reviewed and commented upon in the light of the author's experience with the units described. Some information is given regarding possible modifications of performance by minor changes in the units. Experiences in the application of these units in the field are discussed and suggestions are given to users.

A HIGHER-EFFICIENCY CONDENSING SYSTEM FOR MOTION PICTURE PROJECTORS

F. E. Carlson

General Electric Co.

In motion picture projection optical systems for tungsten-filament sources, the condenser design is such that the source is imaged well ahead of the picture aperture. This position is dictated by considerations of uniformity of screen brightness. It is not the optimal position from the standpoint of utilization of light, for it entails losses at the aperture. At the best position for efficiency, the degree of brightness uniformity is inacceptable because of the non-uniform brightness of the source. The paper describes a method for reducing such losses without sacrificing picture quality.

A WATER-COOLED QUARTZ MERCURY LAMP

E. B. Noel and R. E. Farnham

General Electric Co.

The structure of the water-cooled quartz mercury lamp, its operation, quality of radiation, brightness, and source size limitations are first described, followed by a discussion of the power-supply equipment, both a.c. and d.c. Applications of the lamp are as follows:

(1) Motion picture projection, both with single lamps and with several sources.

(2) Motion picture photography, both black-and-white and color. This part of the paper tells also of an application to very high-speed motion picture photography. For black-and-white photography the lamp is quite satisfactory. For color work the relatively limited red radiation may call for external methods, either in the use of fluorescent reflectors or a highly red-sensitive emulsion, to make up for this deficiency.

GOOD TOOLS PAY FOR THEMSELVES

J. R. Prater

Congress Theatre, Pabouse, Washington

The average projectionist does not equip himself with an ample supply of good tools, and the average theatre management refuses to stock the projection room with anything more than a scant supply of tools of poor quality. After listing the tools that are known to be useful in the projection room the paper points out that were such tools available to the projectionist they would return their original cost in a relatively short space of time by enabling proper testing and alignment of equipment, in addition to facilitating minor repairs of the equipment.

A TECHNIC FOR TESTING PHOTOGRAPHIC LENSES

W. C. Miller

Paramount Productions, Inc.

Different makes of lenses have different properties and characteristics which may render a lens ideal for one purpose and totally undesirable for another. Lenses of a given make and series often vary in quality among themselves. To obtain the best type of lens for a specific purpose it is necessary to subject the various makes obtainable to tests that will reveal the characteristics in such a way that they can be reduced to numerical quantities for comparison. Once the type of lens for a specific purpose has been chosen, it is of great importance to be able to select the best of that type from a group submitted by the manufacturer.

Equipment and technic used in tests that make such discrimination possible are de-

scribed. A few general hints and precautions are given that will aid in determining the characteristics most desirable for various purposes. Special emphasis is placed upon the tests for lenses intended for use with standard 35-mm. equipment. It is a simple matter to apply the methods and principles to other classes of lenses.

A NEW 16-MM. PROJECTOR

H. C. Wellman

Camera Works, Eastman Kodak Co.

The new projector is housed completely in aluminum die-castings, and to provide quietness of operation, the pull-down gears are individually adjusted in assembly by means of an eccentric sleeve. To facilitate threading, the location of the pull-down claw is designated by the threading knob, the position of which can be detected by touch as well as sight. Throwing a single lever engages the rewind mechanism and at the same time releases the lower reel.

A threadlight is built into the projector, so positioned as to be most effective for threading the gate and the sprockets. The single control switch, a new and unique feature, has four positions: the first is the *off* position; the second turns on the threadlight so that the machine may be easily threaded in a darkened room; the third turns on the motor (the threadlight remains on so that the operator can momentarily see that the loops are properly formed and that the projector is functioning properly); and the fourth turns on the projection lamp and turns off the threadlight.

SHRINKAGE OF ACETATE-BASE MOTION PICTURE FILMS

J. A. Maurer and W. Bach

The Berndt-Maurer Corp.

A simple direct-reading film-shrinkage gauge has been constructed with which shrinkage readings may be made in a few seconds. The accuracy of the instrument is such that the maximum variation in a series of readings made upon a particular film will not be more than 0.02 per cent of the predetermined length measured. Readings have been taken systematically with this instrument over a period of five months to determine the shrinkage behavior of acetate-base films under various conditions of storage and use.

The results indicate that the safety-film base made by each of the three American manufacturers has a characteristic value of shrinkage that is ordinarily reached within a few days after processing. Subsequent shrinkage is slow but continuous over a long period of time. The ultimate value of shrinkage is of the order of 1.25 per cent, except in the case of films that have been projected many times on projectors using high-wattage lamps. The bearing of this shrinkage information upon equipment design is discussed briefly.

A NEW FRAMING DEVICE FOR 35-MM. PROJECTORS

Herman A. DeVry

This device embodies a unique application of the silent chain drive to the motion picture mechanism, in such a way that the up or down movement of the film effected by the framer is accomplished without disturbing the synchronism between the shutter and the intermittent. Also, since the framing is done by an overhanging arm built directly onto the intermittent, the intermittent moves only rotationally, and remains always so close to the aperture that there is no room

for buckling of the film. In fact, it is impossible for any buckling to occur due to framing.

A FILM CEMENT PEN
R. J. Fisher

The purpose of this device is to make the application of film cement in splicing film easier and neater, and allow no waste of cement by spilling or evaporation. It replaces the bottle, brushes, medicine droppers, *etc.*, and is a time-saving element where it is necessary to make many splices, as in film exchanges, studios, and laboratories.

CHARACTERISTICS OF SUPREME PANCHROMATIC NEGATIVE
A. W. Cook
Agfa-Ansco Corporation

The new panchromatic negative film is compared with earlier types of super-sensitive material. It has a light-sensitivity twice as great as that of Superpan. This permits a 50-per cent reduction in set lighting, or the use of a smaller lens aperture for gaining greater depth of field with undiminished illumination. Relative color-sensitivity is substantially unaltered. The film is doubly coated, with two emulsion layers superposed upon a gray antihalation layer between the emulsion and the support. Despite increased sensitivity, Supreme negative has equally good keeping qualities, finer grain, and lower developing fog than Superpan.

A CRITICISM OF THE PROPOSED STANDARD 16-MM. SOUND-FILM
J. A. Maurer and W. H. Offenhauser, Jr.
The Berndt-Maurer Corp.

It has been proposed that the standard dimensions of 16-mm. sound prints be changed, principally by widening the sound record and scanned areas. The question is reviewed from the standpoint of the cumulative effects of film shrinkages and mechanical inaccuracies in the steps leading to the final sound print and in the projection of that print, following the method described by R. P. May in the April, 1932, Journal.

A film having sound records of various widths will be demonstrated to support the contention that increased width of sound-track is not needed, and that if any change from the present standard is to be made, it should be in the direction of a narrower track to provide a wider margin outside the sound-track and a wider safety area between the sound-track and the picture.

NEW SAFETY SWITCH FOR MOTION PICTURE PROJECTION ROOMS
Earl R. Morin
Conn. State Dept. of Police

An emergency switch has been designed for projection rooms, which in the event of a fire simultaneously starts or speeds up the ventilating fans, and turns on the auditorium lights. Details are given of the safety requirements for the construction of theatre projection rooms in the State of Connecticut.

A NEW PROJECTOR MECHANISM
Herbert Griffin
International Projector Corp.

This new projector is provided with synchronized front and rear shutters operating in the same direction and providing considerably greater screen illumination; an automatic fire-shutter safety trip for fire prevention; a Bijur one-shot oiling system to provide positive lubrication under pressure, together with ball bearings having sealed lubrication for extremely long service; heavier film-gate construction, the entire unit being readily removable for cleaning and having adjustable tension devices and locking positively both in the open and closed position; readily removable film-trap having edge-guiding means and provision for easily cleaning and replacing worn film runners; a new ring-type fire-shutter governor; easier threading facilities; new automatically positioned threading lamp; illuminated pearl gray enamelled interior; and other distinctive improvements.

A NEW SOUND SYSTEM
George Friedl, Jr.
International Projector Corp.

A brief review is given of the advanced features of the new Simplex sound system, and the considerations involved in developing a high-quality system for small as well as for large theatres are outlined. The en-

gineering requirements of high-quality reproduction are set forth, and the methods employed for meeting these requirements even in the smallest system are explained.

The development is outstanding because of its very low noise level, which insures an effectively wide volume range. The advantages of wide frequency range are preserved by the special care given to the reduction of flutter. The power of even the smallest system is sufficient to reproduce faithfully the latest improved types of recordings, such as the "Hi-Range" prints. The system employs a refined type of rotary stabilizer mechanism, with provision for dual track reproduction, such as from push-pull or stereophonic recordings. Special facilities are provided for mounting and adjusting the projector mechanism.

Change-over controls are of the electronic type employing grid-biasing circuits so as to eliminate switch contacts and mechanically interlocked controls. Standardized power amplifiers of 15-watt capacity with extremely low limits of harmonic distortion are used singly or in parallel for various system combinations. Two-way loud speaker systems are employed, with special switching facilities that simplify checking loud speaker units as well as amplifier characteristics.

THE PROPERTIES AND APPLICATIONS OF OZAPHANE

J. Holloway

The Holloway Company

Chemical and mechanical differences between Ozaphane and gelatin emulsion films are discussed. A report is made of accelerated life tests conducted by the N. Y. Testing Laboratories and the U. S. Bureau of Standards. The duplicating properties of Ozaphane are discussed, and reference is made to the following applications: sound-track, home phonographs, radio broadcasts, organ recordings, *etc.;* microphotography trends, resolution of Ozaphane; color transparencies; toy film, in black-and-white and in color.

The diazo dye process is treated as applied to bases other than cellophane; surface and complete sensitization. A spectrographic analysis is given of diazo dyestuffs and it is shown how projection and sound-track utilizations are affected. Samples of film will be projected and a demonstration will be made of a home phonograph using Ozaphane film.

THE PHILIPS-MILLER METHOD OF SOUND RECORDING

R. Vermeulen

N. V. Philips Gloeilampenfabrieken, Holland

The first attempt at mechanographic recording and reproducing was made as early as 1891 but no successful solution of the problem was applied until the invention of J. A. Miller in 1931. The principle of this invention is described as inertia-free magnification. After the introduction of the principle, the inventor cooperated with the research laboratories of the N. V. Philips Company, of Eindhoven, Holland, in order to solve the problems involved in bringing the system to commercial use.

The method of obtaining a mechanical amplification of forty times is described and illustrated. The mathematical and theoretical advantages of the system over photographic methods are discussed, as also the film or tape that has been specially prepared for this process of recording. Some of the difficulties or precautions that are peculiar to the system and are new to the art of recording, relating to the cutting instrument, cutting material, and the coating of the film, are described. One type of recording machine is described with drawings of the most interesting mechanical parts. A bibliography of articles on the subject is appended.

ELECTRICAL NETWORKS FOR SOUND RECORDING

F. L. Hopper

Electrical Research Products, Inc.

Electrical networks are employed in sound recording for modifying and limiting the frequency - response characteristic. The necessity for their use, application, and design are described. Particular emphasis is placed upon the constant-resistance type of structure.

APPLICATION OF ELECTRICAL NETWORKS TO SOUND RECORDING, REPRODUCING

H. R. Kimball

Metro-Goldwyn-Mayer Studios

The use of electrical networks with recording and reproducing systems to accomplish beneficial results has been steadily increasing. Two types of networks are in general use; namely, wave-filters and attenuation equalizers. This paper discusses in some detail the use of these networks with sound systems as reflected by present practices and later presents practical data for engineering the networks with a minimum of time and effort.

The uses to which attenuation equalizers are put divide these networks into two general classes: first, fixed equalizers to provide fixed equalization for sound channels; and, second, variable equalizers to provide means for varying at will the relative amplitudes of the frequency components of sound signals. Although the means for engineering variable networks is far from beind ideal, the review given in the paper of present practices should be valuable.

INTERNATIONAL

PROJECTIONIST

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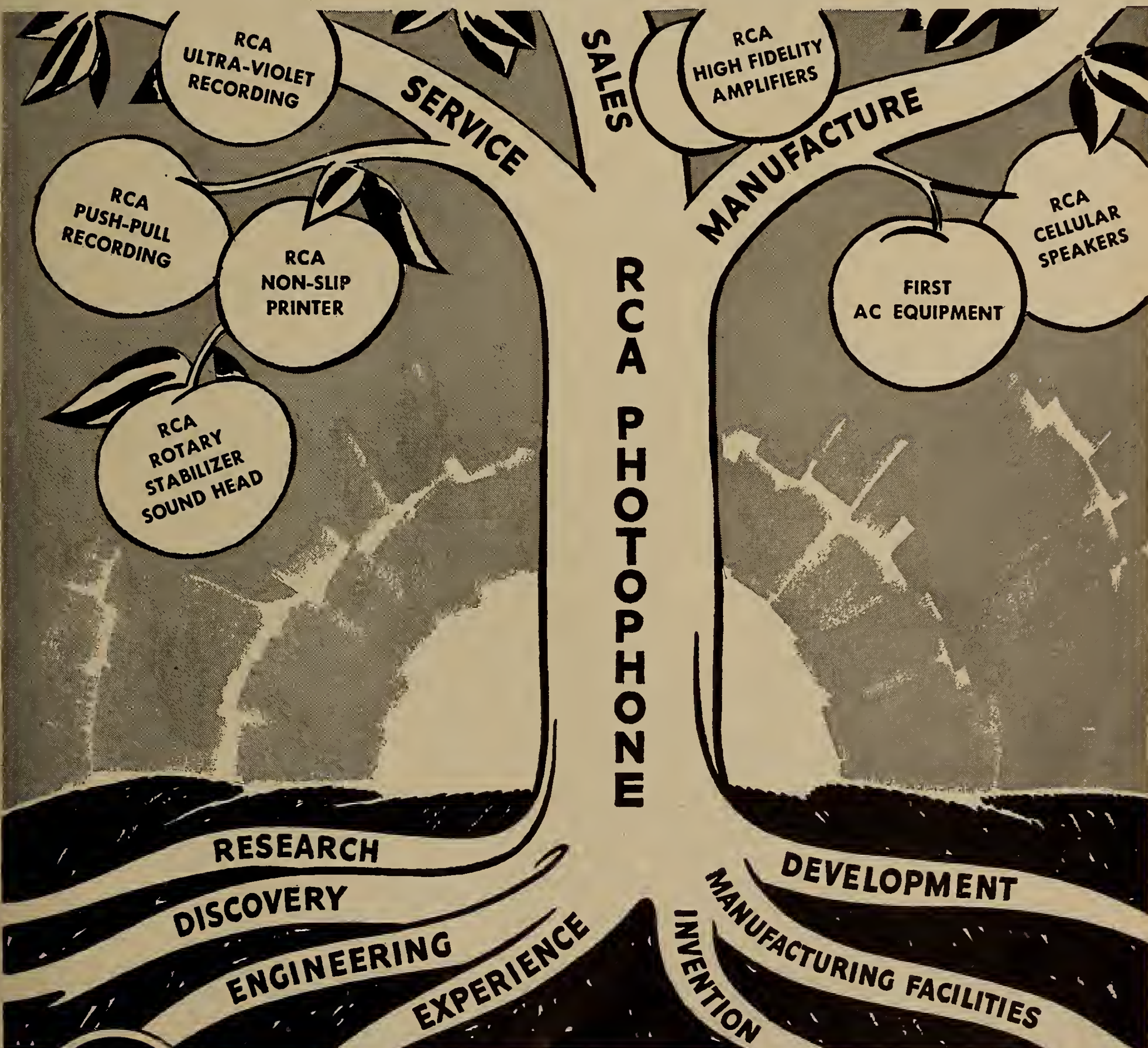

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MONTHLY CHAT

REPORTS from the field indicate that the recent unionization of all sound equipment servicemen has given rise to a genuine spirit of co-operation between the trouble-shooters and the projectionists. Formerly, projectionists considered servicemen as usurpers and a threat to craft security; and the servicemen "ritzed" the "operator" and patronized him all over the lot, feeling vastly superior about it all.

Unionization seems to have effected a great change for the better in projectionist-serviceman relations. Apparently each group now sees it function in its proper perspective as a job involving a certain amount of work for a certain wage. On such a basis of mutual understanding co-operation was inevitable, which circumstance is reflected in improved equipment operation.

• • •

Tall doings are afoot in the 16 mm. projector field, not the least engaging being a tentative plan for a circuit of small theatres to blanket about 5,000 towns in America which now have no motion picture theatre. And in the big towns, too, 16 mm. equipments are forging ahead by reason of technical advances which permit larger screen images of vastly improved quality. This situation will bear close watching.

• • •

IT'S AN old, old saw by now, but we want to restate our firm conviction that efforts to obtain statewide legislation favoring two-men projection shifts is not only futile but actually dangerous business for the craft. We favor a strictly local base for such activity, which is plenty tough enough, as is easily ascertained from those outfits that have been through the mill.

• • •

Now that the so-called double reel has been around for a couple years, we wonder if there is general observance of the absolute minimum footage of 1750 feet per reel. Distributors swore by all that is holy, and by a few things not falling within that category, to observe this deadline. Can we get a few opinions from the field on this? In behalf of Thad Barrows, of Boston, we'll register an emphatic "No" in advance.

• • •

Three more projectionists lost their lives in projection room fires during the past five weeks. Excuse it, but the official reports on these tragedies omitted use of the "fire," stating that "the film exploded." So much for all the gab anent the non-inflammability of film these days, not to mention various "protective" devices.

• • •

NOW that the weather is turning fine, get out in the open, breathe deeply, exercise often, and don't be afraid of a little direct sunlight on your carcass. All of which will help mightily to combat next winter's assault by sundry bacilli and carbon dust.

INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 5

MAY 1938

The Geneva Intermittent Movement: Its Construction and Action

By *A. C. SCHROEDER*

III.

PROJECTORS are more complicated than they would be if no framing device were needed. Probably the simplest device was used on the old Edison machines, where the entire mechanism moved up or down, and only the aperture plate and lens remained stationary. This was simple because the inside shutter moved with the mechanism, and the fact that this put the shutter out of time bothered no one. An outside shutter was added later, which also moved with the mechanism but remained in time because the shaft was directly below the lens and did not change the relative time that the shutter entered and left the light beam as the picture was framed.

Powers had a fairly simple, although not entirely satisfactory, method of framing. Who doesn't remember the old toggle gear and the troubles it occasioned? When the picture was framed it changed the gear center distance, producing a bad condition. It was difficult to keep these gears quiet, and when the gears, toggle lever, *etc.*, wore, they produced backlash in the shutter, with intermittent streaks flaring across the screen when the machine was cranked unevenly.

Simplex attacked the problem in a different manner by revolving the entire movement. The problem was where to locate the axis of the revolving movement. The first thought would be the camshaft, because the camshaft gear must turn in a fixed position; the bearings must remain in one position so the center-to-center distance of this gear and the mating gear remains constant. However, the intermittent shaft would then swing in a circle around the camshaft, also carrying the intermittent sprocket around in a circle and causing complications at the front plate where the film was pulled down.

Revolving the movement about the intermittent shaft as a center kept the sprocket in the same position relative to the front plate and the aperture, but this caused the camshaft to move in a circular path, carrying its gear with it. To drive this "movable" gear it was necessary to have another gear whose center coincided with the intermittent shaft, thus allowing the driven gear to roll around the driving gear as the picture was framed, without changing the mesh of the gears in the least.

Suppose that we hold the flywheel while the framer is moved. Then the intermittent case revolves and carries the camshaft and its gear in a circular path, *causing the camshaft gear to roll around the central gear*. The central gear cannot turn because it is on the flywheel shaft, which we are holding. Thus, by framing the picture the driven gear and the cam have been turned through a partial revolution. What we have done, in effect, is to hold the shutter stationary and turn the cam through a certain angle, thus throwing the shutter out of time.

This has been provided for, however.

Around the intermittent case is a ring with a cam, and, by means of a plunger and a lever, the cam slides a spiral gear along its shaft. This gear is in mesh with a somewhat similar gear. As we move the framer, while holding the flywheel, this spiral gear slides along its shaft and causes the mating gear to revolve, which in turn revolves the shutter, thus keeping it in time.

● Film Transfer Needs Power

The movement requires considerable power during the film transfer; but very little power is needed at other times. Power is needed to pull down the film against the resistance of the tension shoes, and to start and accelerate the parts. The machine runs quite free while the film is stationary, and when the load is suddenly applied in order to move down the next frame, it imparts a severe jar to the gears, bearings, *etc.* To overcome this a flywheel which has a comparatively large momentum is used to drive the cam while the film is moving.

This was quite apparent when the machines were cranked. When cranking very slowly we felt a greater resistance as each frame was pulled down. On speeding up a trifle the uneven resistance was less noticeable, and as the speed increased further the uneven resistance disappeared completely: enough energy had been stored in the flywheel so that it could drive the movement, while one frame was pulled down, without additional power from the crank.

The location of the flywheel is important. If it is placed on the shutter shaft, for instance, all the gears, pins, and other parts between the shutter and the cam are subjected to the uneven torque. This causes undue wear on these parts and occasions considerable noise. The flywheel should be right on the camshaft; but this is inconvenient on the Simplex, so it is placed on the shaft which drives the camshaft. The uneven torque is thus transmitted through only two more gears.

Figure 16 shows the working parts in the Simplex movement. In the upper right corner is the flywheel shaft. In the intermittent case this shaft is in line with the intermittent shaft, the two gears are in mesh and the cam contacts the star. The longitudinal groove in the flywheel shaft is for oil distribution. The shaft runs in a long bearing, and portions of it may starve unless oil is distributed throughout the entire bearing.

End play is adjusted at the flywheel. After loosening the lock screw, the knurled knob is held and the shaft is turned with a screwdriver until a *just perceptible* endwise movement of the shaft is present. With *no* end play, there is danger of the shaft tightening up. Too much end play results in clatter. Be sure to tighten the lock screw again.

Projectionists sometimes notice travelghost after making this adjustment, but fail to connect the two. When the adjustment is made the knurled knob is held, which also holds the shutter stationary. The flywheel shaft is then turned with the screwdriver, thus turning the gears and the cam in the intermittent case. Note that the shutter is stationary while the cam is turned—which amounts to holding the cam and moving the shutter.

Immediately below the flywheel shaft is the camshaft. To adjust end play loosen the lock screw, or screws (on some movements this requires removal of the flywheel). Then the flywheel (or the flywheel shaft, if the flywheel has been removed) is held while the nut on the camshaft is turned until the end play is correct. In all cases the end play should be tested again *after* tightening the lock screw. This holds true for many other adjustments about the mechanism. Locking the adjustment may throw it off, in which case it must be done over.

After adjusting end play in either shaft the movement must turn perfectly free, if it has seen considerable service. On a new movement the bearings will bind enough so that this cannot be taken as a criterion, and makes attainment of proper end play more difficult. In either event the test should be made with the star in the locked position, because the pin may fit snugly in the star, or the intermittent shaft bearings may add a little drag, which throws one off.

To adjust star-and-cam relation the movement is turned so that the cam is directly under the star. The screws on the cover are then loosened and the weight of the cover and the parts carried by it forces the star down against the cam. Only a thin film of oil will then separate them. Tighten the screws again, and the job is done.

Next, in Fig. 16, we have the intermittent shaft with the star on the right end, and immediately to the left is a spiral groove, which also controls the oil; but this one keeps the oil from flowing to the right and out of the bearing, preventing loss of oil and a messy machine. The groove acts like a thread to "screw" the oil back into the case.

● Sprocket Change Procedure

In the center of the shaft are two holes for the taper pins which fasten the sprocket. Unless one has had considerable mechanical experience it is best not to touch these pins, nor to install a new sprocket. However, to help those who may have to change a sprocket, a few pointers will be given.

The taper pins are forced in under considerable pressure, requiring strenuous effort to remove them. Unless certain precautions are taken, this pressure is enough to spring the shaft or damage the sprocket. A device is available to remove and to replace these pins with little chance of trouble. Lacking such a device, the shaft and sprocket are placed on some support so that the metal immediately surrounding the pin rests on it. If this be a block of hard wood, no hole is needed for the pin as it is driven through. However, if a metal support is used, a small hole must be drilled in it so the pin can fall out of the sprocket.

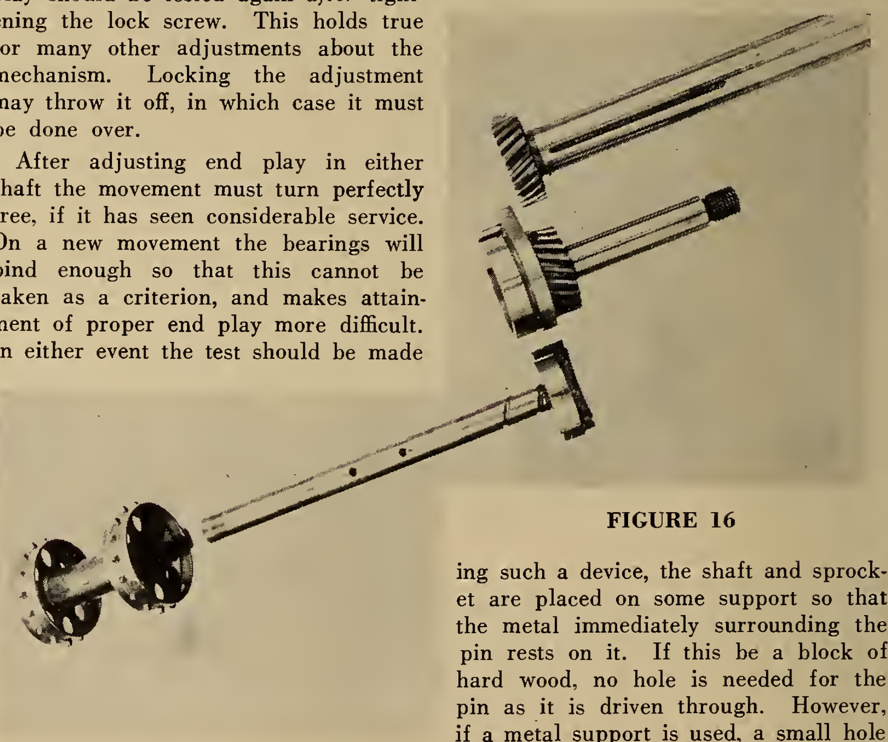
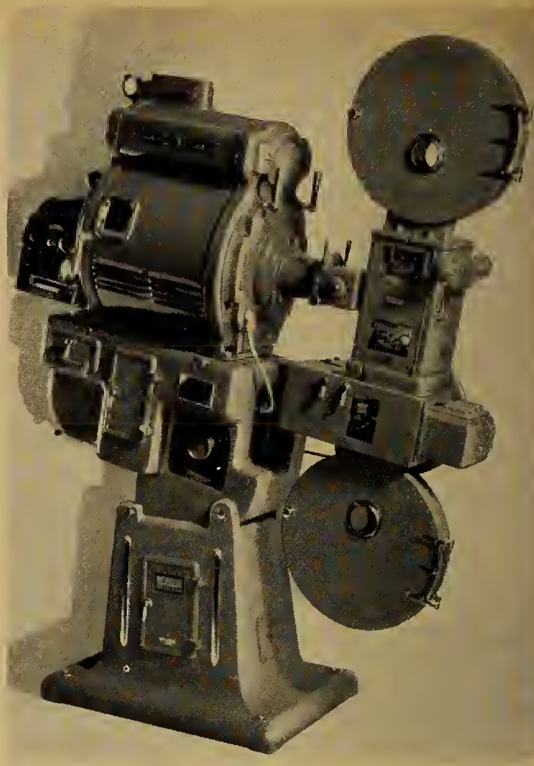


FIGURE 16

A hammer and punch are used to remove the pin, placing the punch on the *small* end of the pin. The punch must not be much smaller than the pin, otherwise it will bury itself and expand the pin, wedging it in the hole tighter than ever.

After removal of the pins the sprocket is slid off. The new sprocket should slide on easily. The holes in the sprocket are also tapered, and the large hole must be adjacent to the large end of the hole in the shaft. After the holes in the shaft and the sprocket are aligned, place the small end of the pin into the large end of the hole. Drive

COMPARE THE EXTRA WEAR



The all-important question to every exhibitor who buys new projectors is this: **Which make will stand up best?**

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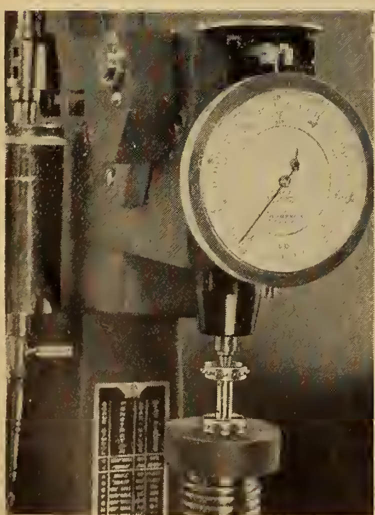
Score-proof removable bronze bearings. They reduce maintenance to an absolute minimum.

Gears that are top-hobbed, and of greater width than those commonly used. This means extra years of service.

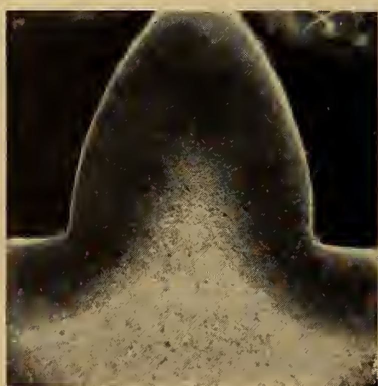
A heavily ribbed cast iron frame that maintains perfect alignment of the mechanism under the most severe operating conditions. Eliminates costly repairs that result from film breakage in the ordinary projector.

There are many other such "hidden value" features in Motiograph. It is important that you have all the facts about this projector before you buy. Your Motiograph distributor will welcome the opportunity to give you this information. Let him show you the projector that is, **"The Standard Of The World."**

The Model "K" Motiograph Projector illustrated above may be purchased at an all-time low price under the convenient terms of the Deferred Payment Plan. Ask your Motiograph dealer for complete details.



Motiograph engineers check the hardness of sprockets and intermittent movement parts by means of this precision hardness tester. Nothing is left to chance in maintaining traditional standards of durability.



This is an actual microphotograph of a section through a Motiograph sprocket. Note the great depth of the hardening (dark outer area). This is the reason why Motiograph sprockets outwear any other make.

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Only Motiograph Mirrophonic Sound offers all three of these outstanding advantages:

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it in securely, but do not use extremely heavy hammer blows. The support must again be used under the central portion of the sprocket. Cut off the projecting portions of the pins flush with the sprocket.

The shallow groove at the left end of the intermittent shaft is for the set screws holding the collar. This collar determines the end play. After loosening the screws the sprocket and shaft are pulled firmly away from the machine, the collar is set up close against the bearing, and the set screws tightened. Do not pull too hard, as the sprocket is light and might bend. If the collar has been set up a trifle snug, loosen the set screws slightly, not enough so that they are completely free. Now tap the end of the shaft lightly until it just turns freely; then tighten the screws. Check the adjustment again after tightening the screws.

The holes in the ends of the sprocket are to lighten it is much as possible and yet retain the required strength and rigidity. Remember that the sprocket and the shaft are started and stopped 24 times a second, and that the heavier the parts, the harder it is to do this, throwing more strain on the rest of the machine and on these parts, too.

Inside the intermittent case is an oil deflector which scoops up oil that is thrown by the star wheel and directs it into the holes to lubricate the bearings. It is a sort of circulating system: oil is constantly draining into the bearings and they are kept practically flooded.

● The Motiograph Movement

Figure 17 shows the parts of the Motiograph movement. On the left is the cam and its shaft. On the left end is a flat spot against which the flywheel lock screw seats. There is another similar flat directly opposite, for the second lock screw. On the right end of the shaft is the cam ring and the pin. Immediately to the left of the cam ring is a heavy disc, which supports the cam ring and also acts somewhat as a flywheel.

Just to the left of this disc is the spiral oil groove. The first impression might be that this is two diagonal grooves or slots, but actually it winds around the shaft and is one continuous groove.

Above and to the right is the star and its shaft. This looks very similar to the Simplex star, but close inspection reveals that the back of the slot is closed by a web, which supports the points of the star just where support is needed most.

Here we have another oil groove, but this is sort of a double affair. A short groove, hardly discernable in the picture, tends to send oil from the star end of the bearing into the center. The other groove, which is about twice as long, returns the oil, keeping it from oozing out of the other end of the bearing. The two holes, of course, are for the taper pins.

FIGURE 17

The cam and star operate in a housing containing a semi-solid grease. In action the parts in the chamber churn the grease and, because of the design of the chamber, so keep the grease in motion that it is continually being forced over and around the parts it is to lubricate.

The flywheel, as indicated previously, is mounted directly on the cam shaft. To adjust end play, two small screws in the face of the flywheel near the outer edge are first loosened. These screws lock the set screws which fasten the wheel to the shaft. The actual locking screws are two long screws, the heads of which are set in the periphery of the flywheel. After loosening these, the flywheel is pushed inward while pulling out on the knurled retaining screw on the end of the cam shaft, thus removing whatever end play exists. The two long screws are tightened first; then the two small screws.

A steel ball is situated at the right end of the intermittent shaft. Beyond this ball is a short plunger which is locked in position by a set screw. To adjust end play in the intermittent shaft, loosen the set screw, push in on the plunger (not too hard), and tighten the set screw.

The star wheel shaft turns in an eccentric bushing which is part of a bracket that also carries the outer bearing. While this shaft has two bearings and is adjusted by an eccentric, it is a far different arrangement than was used on projectors years ago. Both bearings are carried in this bracket, and they cannot get out of line. There is only one eccentric, not two as formerly. When adjusting the eccentric the bracket swings in a circle, carrying the bearings with it and maintaining positive alignment.

● Star and Cam Relation

To adjust for star-and-cam relation, the set screw near the inner bearing is first loosened; then, by means of the two screws which operate against the projection on the bearing bracket, a micrometer adjustment can be obtained by backing off one screw and tightening the other. The position of the bearing bracket can be adjusted *exactly* as wanted: there is no hit-or-miss procedure as formerly, such as putting a punch into a hole in the eccentric and giving it a haphazard pull.

Care must be exercised during the adjustment so that the star is not forced against the cam too tightly. Terrific force can be applied to these parts when turning the adjusting screw. While slowly turning the screw with a screwdriver in one hand, turn the flywheel back and forth with the other hand, but only a small amount, so that the cam ring is always in contact with the curved sides of the star.

Tightening of the screw must stop the instant that the slightest drag is felt on the flywheel. Back off the adjustment *slightly* so that this drag is completely removed. Now see that the bearing bracket is inward as far as it will go, after which tighten the first-mentioned set screw.

Simplex E-7 Tips

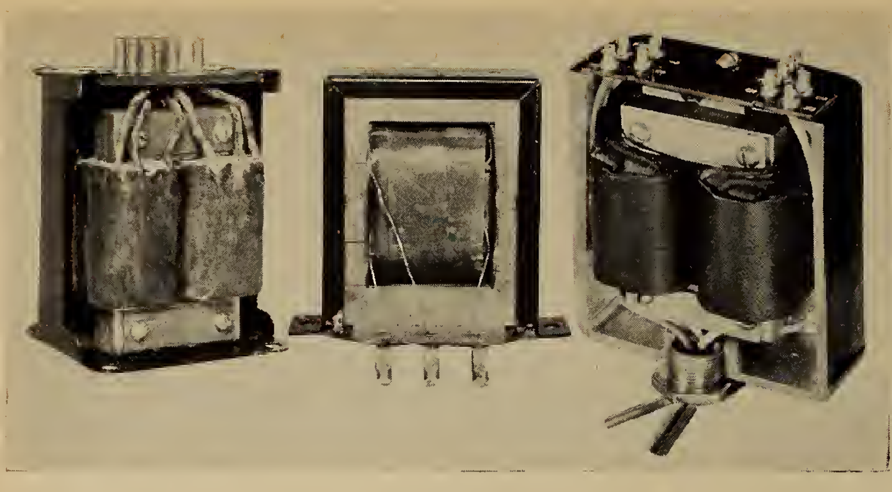
DON'T fill the intermittent movement of the E-7 while the mechanism is in operation. The movement should be filled with Simplex Oil to the indicated level on the sight glasses only while the mechanism is at rest.

Provision is made in this movement to eject any surplus lubricant over and above the predetermined amount. When the projector is in operation the oil in the oil well is splashed and pumped all around the internal structure of the movement. Thus any lubricant added at this time will only raise the oil level and be ejected when the mechanism comes to rest, unnecessarily messing up the equipment and causing the projectionist to believe he has an improperly oil sealed movement.

• • •

Owing to the increased length and larger number of tension shoes on the gate of the E-7 mechanism, a patch passing through the mechanism will make itself heard with slightly more emphasis than on previous models. This should not cause alarm, however, since no damage is done to either the film or equipment.

Projectionists will find that it requires only a short time to become accustomed to the slightly different sound in the operation of the mechanism.



A B C
FIGURE 1

Notes on Audio Amplification

By *L. P. WORK*

THE habit of most projectionists in adhering strictly to practical everyday "cut and try" information in building a working knowledge of sound reproduction often results in a most irrational attack of a technical problem, unless it happens to fall into the particular grooves of their experience. Any approach to a case of trouble should be backed by an understanding of the electrical circuit and the functioning of the various parts of the amplifier or other device involved; otherwise we are working by rule-of-thumb which, although occasionally effective, leads us far astray in the exceptional case—and there are no two cases of trouble exactly alike.

With this thought in mind, a study of audio amplification from the standpoint of design is of value when the system goes "sour" and may reveal a system weakness before outage occurs. The projectionist who has followed the literature in his field since the advent of sound should have a working concept of the terms X, reactance; Z, impedance; C, capacitance; G, susceptance, the reverse of reactance, and others. An understanding of these terms is necessary to follow the analysis of amplifier components.

● Resistance Amplifiers

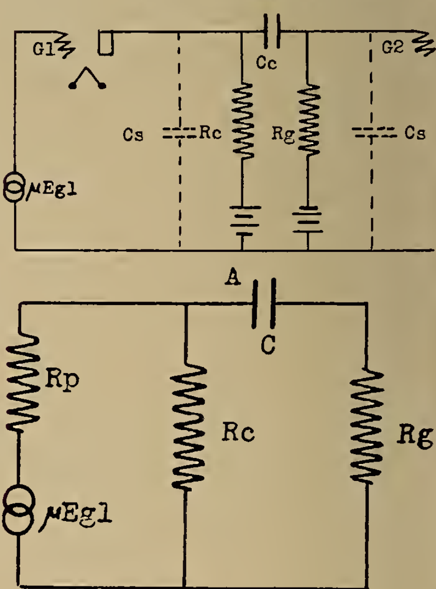
To enable vacuum tubes to work in cascade we must have some means of coupling the plate circuit of the preceeding tube to the grid of the following tube in a manner to pass the speech currents faithfully without upsetting the d.c. requirements of these circuits. In a hypothetical amplifier in which we could connect the plate directly to the following grid without any intervening transfer device, we would have perfect frequency response, limited only by the shunting effect of the stray and tube capacities in the extreme high range. This method of coupling is used in the so-called d.c. amplifier, which we shall not consider as it is not in general use.

The simplest coupling means is had with condensers which pass the speech to the following grid and resistors in the plate and grid circuits across which the speech voltages are developed. Such an arrangement, known as a resistance amplifier, is shown in Fig. 2A wherein the coupling condenser Cc transfers the voltage μEg developed across the coupling resistor Rc to the grid resistor Rg and the grid G. There are two principal detriments of the frequency response: (1) the reactance of the coupling condenser at low frequencies, and (2) the susceptance (reciprocal of reactance) of the shunt capacities Cs . . . at the high frequencies.

Condensive reactance being $1/2\pi$fc, the coupling condenser tends to give a drooping characteristic as the frequency lowers, so when the coupling reactance in ohms is equal to the equivalent resistance of the grid leak resistance in series with the paralleled plate resistance and the plate resistor, the amplification drops to about 70% of the middle range (equivalent Fig. 2B).

The effect on the bass of varying the coupling reactance is shown in Fig. 3 (left half) with four sizes of coupling condensers in the typical resistance stage: the smallest, c = .005 mf., has the highest reactance and the poorest bass response; and the largest capacity, c = .05 mf., the best response. On the other hand, the shunt susceptance of the stray wiring and tube capacities causes a drooping characteristic when the frequency becomes high enough to produce sizable losses through their combined shunt load on the signal.

When this shunt capacitance has a reactance equal to the equivalent plate, plate coupling, and grid leak resistance in parallel, the high-frequency response will drop to about 70% of the middle range. The effect of varying the shunt capacitance by selection of tubes and control of stray wiring capacities is



B
FIGURE 2

shown in Fig. 3 (right half) wherein the least capacitance, 15mmf., gives the best high-frequency response. Since it is the ratio of the coupling reactance

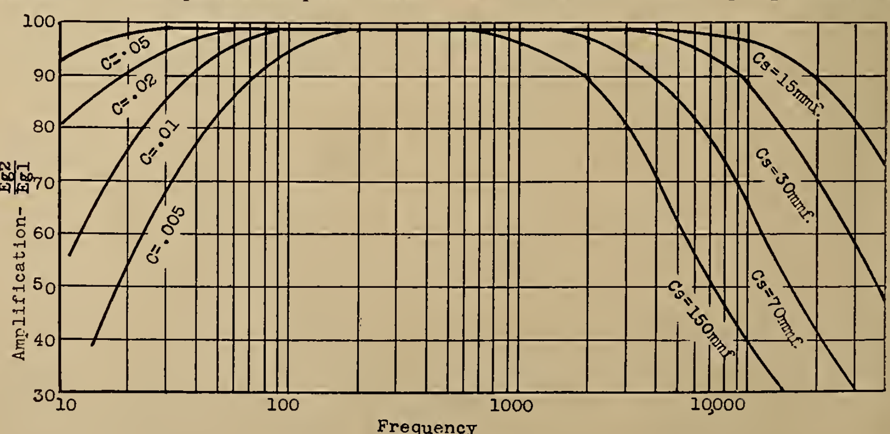


FIGURE 3

Already more than 5000 theaters have installed high intensity projection. With high intensity projection in one theater out of every three, audiences are rapidly becoming aware of the difference. They are seeking out the theaters that provide better picture quality on the screen, more comfortable seeing and more pleasant general illumination. With old style low intensity projection there is seldom enough light on the screen for good, comfortable seeing even in the best seats. At the back of the house screen brightness is so much reduced that pictures are dim and unsatisfactory.

Modern fast action and the new color pictures call for Simplified High Intensity projection. "Simplified" means new type lamps and "Suprex" Carbons. These have so reduced the cost per light unit on the screen that any theater can now afford high intensity projection.

The illustrated booklet, "The Eternal Triangle in Picture Projection," will tell you about it. Write for a copy.

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and the shunt capacitance to the combined tube, plate, and grid resistance which determines the droop at the extremes of the audio range, it is evident that there is an optimum value for these resistances.

In practice, the size of the plate resistor is determined by the plate resistance Rp, a common value being 2Rp; while the grid resistor will run from 2 to 10 megohms. Resistance coupling to the last or power stage using large power tubes, such as the 242 or 845, is unsatisfactory due to the limiting effects of the tube input capacitances and the shunt loading imposed by the low value grid resistors which such tubes require.

A word might be said about phase inverters, which are a form of resistance coupling used to drive push-pull output stages of medium power. Thus far they have not become a general substitute for a good driver transformer.

We can never realize the full voltage developed in any resistance coupled tube because (1) the drop due to the tube plate resistance; (2) the drop through the plate coupling reactance, and (3) the shunt load placed on the following grid by the grid resistor. Therefore, the useful voltage gain per stage is something less than the tube gain alone; yet in spite of these sacrifices it is widely used as a means of voltage amplification in modern high-gain amplifiers.

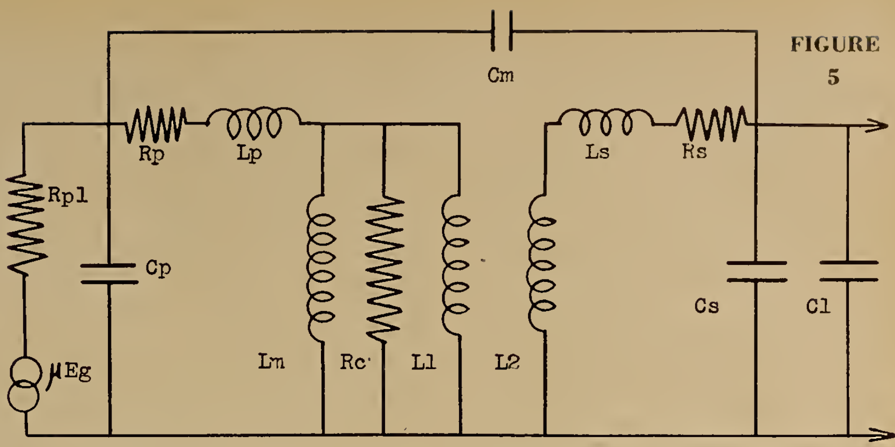

FIGURE 5

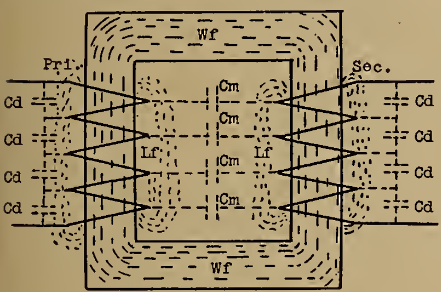

FIGURE 4

The Transformer Amplifier

The audio transformer as an impedance adjusting device makes possible our present-day sound systems. Circuits associated with vacuum tubes are inherently high impedance and cannot be handled expeditiously without some terminating devices to translate them into reasonable working values. It is difficult to show the need of impedance matching in a simple manner, yet the following analogy will convey some idea.

Two horses, one light and fast, the other a draft horse for moving slow heavy loads, might produce the same ton-miles per hour (power or wattage) when working at their respective best loads (impedances). But if we harnessed the light horse to a heavy load which he was able to move, the ton-mile or efficiency rate would be low due to the mismatch in impedance between the generator (horse) and the load (the wagon). Likewise, the heavy horse on the light load would produce a poor work-rate.

When considering potential as equivalent to speed, the first equine example might be compared to a high-impedance generator working into a load of low impedance; while the second such example might be compared to a low-voltage, heavy-current generator working into an impedance too high for an efficient transfer of power.

A schematic of an audio transformer is given in Fig. 4 showing the primary, Pri, wound on the left leg of the core; the secondary, Sec; working flux, Wf, by the dashes; leakage flux, Lf, by the dots; distributed capacity by the small dotted capacities, Cd . . . , and the mutual capacity by Cm. The transformer action, stated in simplest terms, is: the current in the primary coil produces flux in the core which by magnetic induction induces a similar current in the secondary. When the turns ratio of these coils is one-to-one, the voltage induced is equal to the primary voltage; when any other turns ratio N is used, the voltage step-up is directly proportional to N, while the impedance ratio is equal to N^2.

Equivalent Network Analysis

The best way to analyze the action of the device and to visualize the effect upon response is by the equivalent T network of a transformer as given in Fig. 5. Here the voltage μEg developed in the tube is reduced by the plate resistance Rpl, then applied to the network with Cp, Cs primary, and secondary distributed capacities; Rp, Rs primary and secondary copper loss; Lp, Ls primary and secondary leakage inductance; Lm, primary inductance; Rc, core loss; L1 and L2 are fictitious inductances to maintain the phase relationship in the actual transformer, and Cm the mutual capacity between the windings.

This exact equivalent circuit of a transformer-coupled stage may be simplified by dealing with limited portions of the frequency range at a time, while retaining sufficient accuracy for ordinary purposes. For more convenient analysis the simplified equivalents for the low, middle, and high ranges are given at Fig. 6A, B, and C, respectively. The difficulty in producing an audio

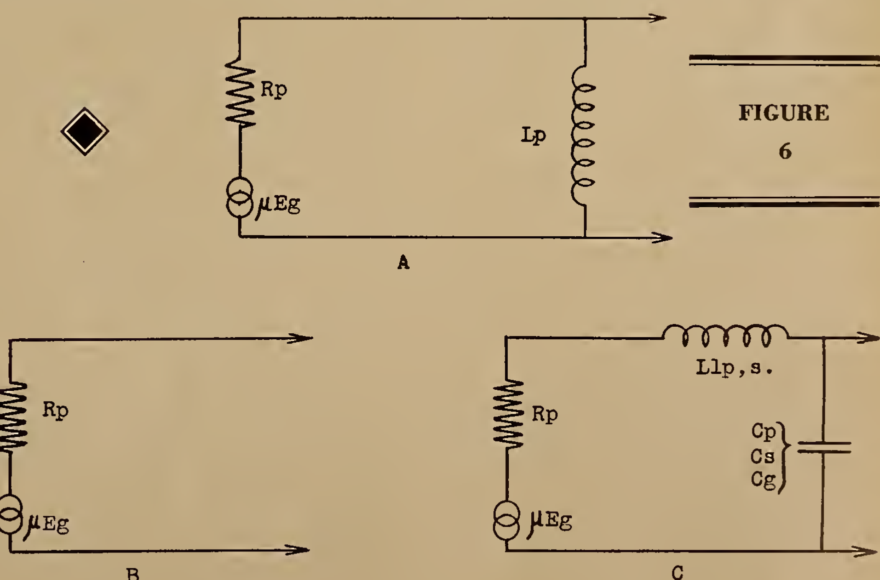

FIGURE 6

transformer with good overall characteristics is due to the fact that it must act as well at 10,000 as at 30 cycles; it is comparatively easy to build for a single frequency.

Practically the only limiting factor in the reproduction of the low range is the inductance of the primary, which at the lowest frequency desired should have about three times the reactance in ohms as the plate resistance of the tube from which it works. This may be obtained by increasing the primary turns and also by raising the permeability of the core. But since increasing the primary turns increases the necessary secondary turns by N times in order to hold a given ratio, there are definite limitations here, as we shall see. And many high permeability core materials are quite sensitive to mechanical and electrical shock, so that their characteristics may be changed accidentally.

The effect of different values of primary inductance is given in the left half of Fig. 7 wherein the smallest inductance, 20 henries, gives the poorest bass, and the largest inductance, 80 henries, the best. High permeability cores not only raise the primary inductance but improve the ratio between the working and leakage flux, because the leakage flux is in the air surrounding the coils and depends on the physical aspects of design. Hence a relative increase of working flux reduces the leakage resistance and so extends the high-frequency response by raising the series-resonant point. Actually it is the incremental permeability or that response in flux to the speech currents superimposed on the d.c. primary flux in which we are interested, and this is sometimes quite different from the permeability displayed in absence of plate current.

Core materials display losses which increase sharply with flux density, giving rise to a maximum which must be observed in keeping eddy current losses to a minimum. By increasing core size, other factors being constant, we reduce flux destiny; but we increase leakage inductance and thereby reduce the high-frequency response. With constant applied voltage the density is inversely proportional to the frequency, so that the core loss shows up greatest in the low end where it adds to the primary shunting loss and lowers the bass response.

The element of core loss becomes most important in sizable output transformers where flux densities are high due to the power handled, but in this connection a redeeming factor obtains by reason of the relative minor effects of leakage reactance and distributed capacity thereby permitting larger size.

It is for the purpose of obtaining better primary inductance through improved magnetic performance that parallel feed is used in high-quality amplifiers; while in push-pull output transformers a cancellation of this flux is obtained by the opposition of the d.c. flow in the halves of the primary winding, thus giving a more faithful transfer of the signal to the secondary.

The middle range of frequencies is treated as if the circuit were as Fig. 6B, which gives the essentially flat middle portion of the response curve. In this middle range the shunting effect of the primary is so small as to be a virtual open circuit, while the capacities shunting the secondary still have a reactance high enough to be ineffective. There are no special considerations here except to note that phase and amplitude distortion still may be present.

This part of the audio spectrum gives rise to the most trouble in design of leakage inductance and capacitative reactance, as shown in Fig. 6C, a simplified network accurate at high frequencies. There is unavoidable capacity created in the secondary winding by the many turns needed to obtain a useful ratio to the primary. This turn-to-turn capacity, the capacity to ground, and the capacity of the input wiring plus the tube input capacity, are grouped in one condenser Cp, Cs, Cg (Fig. 6C).

In transformers with both windings of low impedance, such as are used in line-to-line or mixing applications, the distributed capacities are so low as to be negligible in the entire audio range. Another element, leakage reactance or inductance, shown by the dotted flux lines in Fig. 4, combines with distributed capacities to give resonant phenomena that produce erratic effects in the high range.

This leakage reactance is caused by the flux which is not mutual to both the primary and secondary windings and exists to some extent in the best designs. It acts as a choke coil or reactance in series with the network and tends to have a gradual lowering effect as the frequency rises, until a point is reached where it produces series resonance with the shunt capacity Cp-Cs-Cg, when a distinct rise or hump is produced which was very common in older transformers.

The right half of Fig. 7 illustrates this resonant effect of leakage reactance with three conditions of shunt capacities. It is interesting to note that some leakage resistance is desirable inasmuch as shunt capacitance cannot be eliminated. This fact is shown by the best curve Cs=1600mmf. Interleaving the coils by winding several sections of the primary between sections of the secondary, or by using a "pie" arrangement, will reduce the leakage inductance greatly, but at the same time it increases the shunt capacitance so that the high-frequency gain from this means is limited.

There are many conflicting elements in the construction of a transformer, because complete satisfaction of any one requirement invariably works to reduce the net gain through destructive effects on some other phases. For instance, we would like high-turn ratio in order to give the best step-up and thereby reduce the stages needed. Conceivably, if this were unlimited, all amplifiers might be reduced to two stages: one stage as a driver working into a push-pull stage to supply power. But as we increase ratio the losses quickly overtake this factor, so that a point is soon reached where additional ratio actually gives less gain.

Good design dictates ratios in the order of two-to-four, with transformer insertion losses of about 1 db. The insertion loss is dependent principally upon the copper losses of the windings and the core losses, while at the low frequencies the magnetizing current adds to the total loss.

Figure 1 shows the construction of three representative transformers: A, core type with layer windings; B, shell type; and C, core type with high permeability cast case which can be turned after mounting to obtain adjustment for least stray coupling.

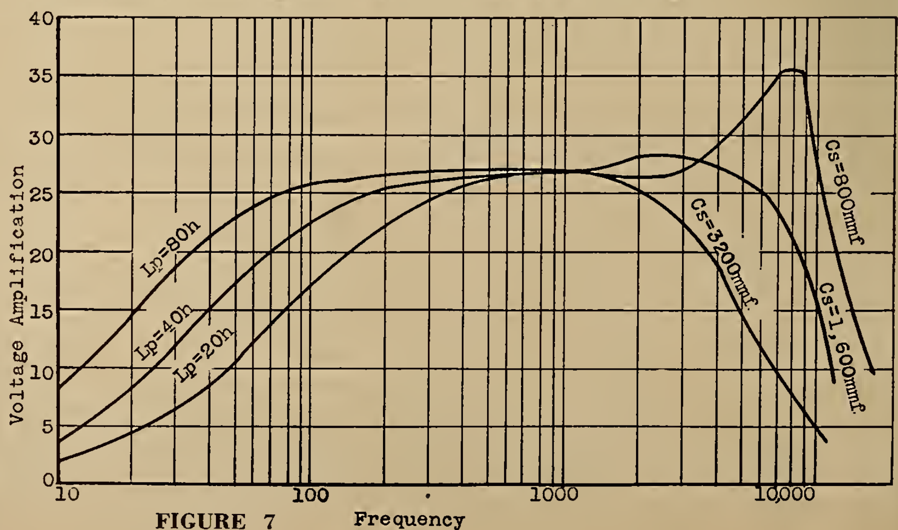

FIGURE 7

Measuring Projected Light and Screen Brilliancy

By *J. A. COOK*
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IF A cat were in the third row in a perfectly dark theatre except for the light on the screen being projected through a running projector, and this light were gradually increased from 4 foot-candles to 15 foot-candles I wonder whether the cat would sense any change in illumination? The area of the pupil of a human eye does not vary exactly in proportion inversely as the illumination on the screen, therefore a person would sense a decided change.

At present the best authorities are advocating an effective surface brilliancy of 7.5 foot-lamberts on the screen. By "effective" is meant with the projector running without film in it. This means that the screen must be very clean and have about 12 foot-candles of effective illumination.

Assume that we have a Suprex lamp burning 60 amperes at 34 volts issuing 3000 lumens of light through a running Super Simplex head on to a new diffusing sound screen 13.5 x 18.5 feet or 250 square feet. The average effective illumination on the screen would then be 3000 divided by 250, or 12 foot-candles.

If a light meter held at the screen with the cell toward the projector read 12 f. c. of effective screen illumination, and when reversed to read the reflected light from the screen (avoiding shadows), read 6 f. c., we would have a reflection factor of .50. The screen brightness would be 7.5 foot-lamberts, as the reflected light read in foot-candles, which was 6.0 multiplied by 1.25, gives us the 7.5 foot-lamberts. 1.25 is a given constant.

With the advent of the new low-priced light meters, everyone confronted by lighting problems should become accustomed to using these light meters and be thoroughly familiar with the five highly useful yet simple illumination terms: *foot-lamberts, foot-candles, lumens, reflection factor* and *candle power*. No definitions of these terms are offered here, as the interested reader should be familiar with the information contained in various free educational bulletins[1].

The usual method of measuring projected light in a theatre is for one person to stand at the screen with the light meter while another stands by the projector. This is very unsatisfactory, as communication is slow and the light varies continuously due to many factors. The person with the light meter at the screen doesn't know what the voltmeters and ammeters on the arc lamp read at the instant the screen illumination reading is taken; nor does the projectionist know what the illumination is when he reads his room meters.

All points on the screen read differently, with the center the brightest. There is usually a considerable difference between the two screen sides shown by meter readings but not easily noticed by the eye. Inaccuracies result. Also, there may be patrons in the house, or the show may be on when it is desired to take readings.

The main purpose of this article is to outline a simple method of measuring the effective lumens projected through a running projector without film right in the projection room, as now practiced by the writer.

In order to do this it was necessary first to find some material upon which we could pick up all of the light projected right in front of the projector and diffuse it so that the total amount of light flux (lumens) could be determined by the reading of the reflected light with a foot-candle meter.

Calibration of Paper

After some correspondence with the engineers at General Electric Co.[2], we finally selected the white paper employed for photographic printing as being the most satisfactory as a field standard for this work. Regular glossy Azo paper can always be obtained in any locality and is so uniform that any new supply need not be recalibrated. To use the paper as a field standard it must be developed without exposure, fixed, washed, and dried so that there will be no discoloration on the emulsion side. The back side (not the glossy side), provides the white surface of high reflection factor and is undoubtedly as free from gloss as any paper that is reproducible.

The paper is calibrated as follows: a small round hole (9/32 inch in diameter) was drilled in a piece of sheet brass. The size of the hole isn't important, except that it be as round as possible. This was placed over the projector aperture and held in place by closing the "E" gate. A half-size E.F. 7.75-inch lens was used. A paper ring with a 2½-inch hole was used in the front of the lens to make the diameter of the light beam in front of the projector as small as possible.

As soon as the light was thrown on the screen and focused, the brass plate was moved until the round spot on the stage screen was exactly in the center. The spot was exactly 3.5 feet in dimaeter, as the throw was 96.5 feet; the lens was 7.75 inches E. F., and the drilled hole was .281 inch in diameter. The area of the spot on the screen was 9.62 square feet.

The lamp was burned several minutes so that the light was quite steady. The illumination on the 9.62 sq. ft. of screen was uniform at 46 foot-candles, making a total of 9.62 times 46, or 442 lumens being projected. The same meter that was used on the stage was used in the projection room.

The prepared Azo paper had previously been fastened to a flat thin board. A white cotton-covered No. 26 copper wire had been threaded through the center of the paper, through the board and fastened to the back of the board. This wire was to be used subsequently to facilitate measuring the distance between the meter and the paper surface. The Azo paper to be calibrated was then held about 8 inches in front of the projector lens to pick up and diffuse 80% of the 442 lumens of light. (Azo paper is 80% efficient; the other 20% is absorbed, but this plays no part in our procedure.)

The Azo paper was held in the beam as one would hold a mirror. The point where the No. 26 wire entered the paper was kept in the center of the beam. The wire was held in the same hand as the meter, so that the latter could be slid up the wire. The paper was angled to give the highest meter reading, that is, the paper surface was adjusted so that there was an angle of about 20 degrees between the center ray of the projected beam and a line drawn from the center of the spot to the meter, which was held to the right of the projector.

The incident and reflection angles both were about 10 degrees. The meter was slid up the wire until a reading of 46 foot-candles was obtained. The light-active element in the photoelectric cell was found to be exactly 20.75 inches from the Azo paper surface.

The aforementioned readings on the

[1] "Fundamentals of Illumination" Bulletin L.D. 1-A, and "Illumination Design Data" Bulletin L.D. 6-A, issued by the Engineering Dept., General Electric Co., Cleveland, O.

"Da-Lite Screen and Movie Accessories" issued by Da-Lite Screen Co., 2723 Crawford Ave., Chicago.

"Suggestions for Exhibition" issued by Technicolor Motion Picture Corp., Hollywood, Calif.

[2] Nela Park, Cleveland, Ohio.

stage and in the projection room were repeated alternately many times to ascertain that there was no error of any importance. The total lumens projected being 442, we knew that the multiplying factor for our meter reading at 20.75 inches was 9.62; therefore at 33.4, 47.2, and 66.8 inches our multiplying factors were 25, 50, and 100, respectively.

As a matter of economy, the writer does not use Azo paper. There happened to be available several pads of pure white diffusing paper which were calibrated as described above. These pads are not as efficient, however, therefore we use distances of 32.3, 45.5, and 64.6 inches for multiplying factors of 25, 50, and 100, respectively. Of course, any good diffusing paper with no gloss can be calibrated as described.

● The Measuring Procedure

For field work the exact values are not nearly as important as ratios. Ratios are the ever-important factors in the system outlined for measurement of effective light and are sufficiently accurate to assimilate data for aid in making accurate decisions. The carrying of decimals is to assure correct mathematical equations.

To measure projected lumens using standard equipment from a position in the projection room, the procedure is as follows:

Fasten a sheet of prepared Azo paper onto a flat board. Thread a small wire through the center of the paper and secure the end to the back of the board. Then tie knots 33.4, 47.2 and 66.8 inches respectively, from the front surface of the paper as aids for spacing the meter definite distances from the paper.

With the projector running normally without film, project the light through the standard aperture lens, and rotating shutter onto the paper about 8 inches in front of the lens. Hold the paper at the same angle that you would a mirror, to reflect the projected light onto a light meter. (The writer uses a G.E. Model 8DW4OY1 light meter.) The meter should be held about one foot to the right of the lamphouse.

● Working Distance Vital

The distance from the projector lens to the paper surface is unimportant as long as no light is wasted over the edge of the paper or the spot on the paper is not partly shaded from the meter by the machine. The distance from the *paper surface* to the *light-active element* in the photoelectric cell in the meter is *very important.* The intensity of the light at the meter varies inversely as the square of the distance between the surface of paper and the meter.

If the spot on the paper were very small and the meter held 6.68 inches from this, the meter would read directly the total lumens projected. This is our starting point.

With low-intensity lamps hold the meter 6.68 times 5, or 33.4 inches, from the paper. The meter is just to the right of the lamphouse as mentioned previously. The total number of effective or usable lumens given out by the lamp through the running projector is then equal to the meter reading in foot-candles multiplied by 5 squared, or 25. The product is then divided by the area of the picture on the stage screen in square feet to obtain the average effective screen illumination in foot-candles.

For lamps using Suprex carbons, the meter is held either 47.2 or 66.8 inches from the paper surface, and multiplying factors of 50 or 100, respectively, are used.

Precautions: the surface of the paper must be kept very clean and should be replaced often. Have all light out except the one being measured. *Avoid reflections from the aperture plate.* Avoid reflections from white shirts. The light meter should be calibrated daily. Do not have iron within two inches of the meter while making readings.

This method of checking projected light is a great aid in making lamphouse comparisons and adjustments. By following the foregoing simple instructions and observing the stated precautions, uniform results can be obtained. The foregoing, if read hurriedly, might seem complicated, but the system is really quite simple after being followed through or

TABLE A

Carbons	Amps.	Volts	Watts	Lumens	Relative
SRA 8 & 12	32	55	1760	2300	100
Suprex 5 & 6	40	34	1360	3100	135
Suprex 6 & 7	45	34	1530	4500	195
Suprex 6.5 & 8	60	44	1980	5300	230
Suprex 7 & 8	65	37	2405	6200	270

Technicolor Advises Theatres On Proper Handling of Prints

THE full beauty of Technicolor prints will be obtained if running houselights of strong color and high level of illumination are not lighted during projection. Illuminating fixtures whose lighting units are visible to any part of the audience detract from screen interest. Colored light should not be projected onto the screen or stage proscenium during the projection of a color picture.

Chandeliers illuminated with other than very dim soft hues should not be lighted during the projection of a color picture. All general lights other than aisle and exist lights, particularly chandeliers, domes, *etc.*, under balconies which project over the orchestra floor, should be out.

The following suggestions arise out of a long series of studies and observations directed toward getting the best result from the projection of Technicolor prints. The Technicolor process produces prints that are rugged and capable of long life under normal projection conditions.

The print should be stored, cleaned and handled in accordance with approved practice for black-and-white prints. Surface dirt and oil may be removed from Technicolor prints by carefully rewinding them through a soft cloth pad moistened with clean carbon tetrachloride. The optical system of the projector, including condenser lenses, the projection lens, and the glass in the projection room port should be kept free from surface dirt. Smears can be removed with a soft cloth moistened with clean alcohol, while dust can be removed by a soft camel hair brush.

The screen should be well and evenly illuminated for improved projection.

The density of Technicolor prints is controlled to produce a satisfactory screen image when the light falling on the screen is approximately 10 foot-candles. This illumination level can be checked by measuring the light falling on the screen with an instrument like the Weston Junior Photometer. This is done by holding the instrument just in front of the center of the screen with the light-sensitive cell directed toward the projector, the latter running at normal speed and arc trim but without film. When this illumination falls on a clean, flat white screen, it results in a brightness of 7½ foot-lamberts.

Arcs on incoming projectors should burn for at least two minutes before the changeover, so that the incoming lamp is up to operating temperature. This will decrease the possibility of a color change in changing from one projector to the other. Focus be checked at the beginning of each incoming reel; an opera glass will be found very helpful in setting precise focus, because of the distance between projection room ports and the viewing screen.

applied a couple of times step-by-step in actual practice.

As long as nineteen years ago the writer was a member of the "Ten Foot-Candle Club" and at that time there was a movement to obtain uniformity in illumination; yet today we still find effective surface brightness on theatre screens varying from less than 1 foot-lambert to more than 12 foot-lamberts. A screen light level of foot-lambert is far from being adequate for color pictures. It is not at all unusual to find a difference of more than 20 percent between the effective lumens from two projectors in use in a theatre. I believe this irregularity is as serious as an unbalance of either quantity or quality of sound between the two machines.

In addition to the readings taken in the projection room it requires only a few seconds to secure the two readings at the screen in order to obtain the screen reflection factor. These two readings should be retaken several times in rapid succession after the lamp has attained steady, uniform operation, and without the projector running for ultimate accuracy. For still more accuracy an E.F. 8-inch lens can be used.

Data for the reflection factor, then, is the only thing that need be taken at the screen, as the lumens divided by the square feet of picture, multiplied by the reflection factor, multiplied by 1.25 gives effective screen brightness in ft.-lamberts.

Table A was copied from a manufacturer's bulletin. Data anent lamphouse, projector aperture size, or whether the projector was running were not given, but the writer assumes from the values that the aperture was .600 x .825 inch and that the projector was not running.

Do not confuse the amount of lumens shown in Table A with the amount of effective lumens obtained with the projectors running.

Distribution of light on the stage screen also should not be overlooked. The four main factors that control this are, lamphouse, type of projector, shutter, lens and operation by the projectionist. This is a problem within itself.

If 7.5 foot-lamberts of effective screen brightness can be obtained with good contrast and definition, ideal results can be expected. However, in our effort to obtain ideal effective brightness we must not sacrifice contrast and definition. By "contrast" and "definition" we mean that black should be jet black, and white, snow-white, not gray, and all lines sharp, not colored or hazy.

It is better to sacrifice light for contrast and definition than *vice versa*, as the pupils of our eyes will attempt to compensate within reasonable limits for intensity of light, but there is nothing to compensate for a lack of contrast and definition.

New Simplex Air Deflector and Aperture Cooling Unit

By *HERBERT GRIFFIN*

VICE-PRESIDENT, INTERNATIONAL PROJECTOR CORPORATION

OCCASIONALLY we receive complaints with regard to the E-7 mechanism similar to those we received in the past relative to the Super Simplex mechanism, *viz.*, that the rear shutter disturbs the arc and interferes with the projection. In the case of the Super, it was only necessary to tell the customer to remove the vanes from the shutters, whereupon almost everything cleared up as far as arc disturbance was concerned.

In the case of the E-7, the rear shutter was purposely designed to greatly reduce the temperature at the aperture plate below that of the Super, because the E-7 greatly increases the light on the aperture. One cannot remove the vanes on the E-7, so that the type of shutter used in front of the E-7 has in some cases been substituted for the ventilating rear shutter. Result: the heat at the aperture plate has gone up tremendously—much more than in the case of the Super when the vanes were removed, due to the greatly increased amount of illumination obtained with the E-7 mechanism.

This presented a difficult problem: we did not want to decrease the amount of illumination obtainable, but we did want to maintain the cool aperture plate and at the same time not disturb the arc. The problem has been solved and an advantage ensues. It comprises an assembly which fastens to the rear-shutter housing in place of the usual cone, the assembly consisting of a metal housing into which slides a metal holder encasing a circle of optically flat, clear heat-resisting material.

● Advantages of Assembly

The introduction of this assembly in the place selected does definitely four things:

1. It absolutely prevents any disturbance of the arc, thus maintaining the latter at its highest efficiency.

2. Using a 65-ampere arc and with the E-7 shutter running, the temperature reduction at the aperture plate ordinarily is in the order of 900 degrees F. With the addition of the aforementioned unit a *further reduction* of approximately 200 degrees is obtained.

3. It greatly improves the quality of the projected picture, and all of this with a noticeable improvement in illumination. This last sounds incredible, but it is a fact nevertheless and is readily perceived by sliding the unit in and out while observing the screen.

4. Noise in the projection room from movement of air is eliminated.

These units will be supplied no charge on all existing installations of E-7 mechanisms. and as standard equipment with all shipments of new E-7s. Due to the increased diameter of this unit, there is no longer any spill-over of light between the lamphouse and the mechanism.

Because of what we consider to be a tremendous improvement obtained with this unit, we are also developing it for

Air deflector, aperture cooling unit

use in connection with the Super Simplex mechanism, so that it will be possible to replace the vanes which have been removed from the shutters and give the users of Super mechanisms, at a charge of about $15, the same relative advantages as will be obtained with the E-7, that is, a reduction in aperture temperature and improvement in picture quality. Patents are being applied for.

Considering the great reduction in heat possible by the use of the E-7 shutter, plus the aforementioned assembly, it is not improbable that fire inspection authorities throughout the country will insist upon this type of equipment. Then, too, it must be remembered that with such low temperature now possible, damage to film through distortion and buckling, caused by excessive heat, will be eliminated.

Analyses of Modern Theatre Sound Reproducing Units

By AARON NADELL

VI. Amplifier Trouble-Shooting

FIGURE 1 is a block schematic representing a single amplifier. It pictures neither the physical construction nor the actual wiring of the amplifier, but only the way in which the principal components are related to each other in operation. As in all block schematics, each connecting line stands for a *pair* of conductors. The four rectangles shown do not relate to individual units within the amplifier, but indicate a function or service performed by a group of units.

The schematic of Fig. 1 is given in Fig. 2. In addition to being a useful model for the most modern problems of trouble-shooting, the apparatus diagrammed, the power amplifier of the new Simplex sound system, incorporates some novel features of interest in themselves. For example, inclusion in the reverse feedback circuit of both the volume control and the low- and high-pass filters. It should be noted that these filters are distinct from the speaker network; they do not divide sound between the two groups of speakers, but modify the overall amplifier response to suit various acoustic conditions.

These and other arrangements found in Fig. 2 still are far from common, but in line with the trend of the most modern amplifier evolution. It will, therefore, be of interest for more than one reason to analyze the circuit of Fig. 2 in detail before relating it more closely to Fig. 1 and to the ways in which the latter is helpful in tracing trouble.

The power input of Fig. 2 will be found at the lower right-hand corner, the 110-volt circuit running through a 2-ampere fusetron to the primary of the power transformer, which is tapped to accommodate line voltage variations. Three secondaries are provided, the lowest supplying 6.2 volts to the heaters of the amplifying tubes. This winding has a center tap connection, the function of which is explained hereinafter. The center secondary supplies 3 amperes at 5 volts to heat the filament of the full-wave rectifying tube, seen just above and to the left of it. The top secondary supplies 390 volts to the plates of that tube. The center tap of the top secondary is the negative terminal of the d.c. output of the rectifier, the positive d.c. terminal being the filament of the tube. The center tap is grounded to the common negative bus, which in turn has an external ground to a water pipe.

Tracing the d.c. circuit and its branches from positive to negative, one line can be seen running upward from the tube filament. Just above the tube a branch runs right and out of the drawing to carry "B" voltage to a monitor amplifier. The main line continues up to the center tap of the output transformer and thence to the plates of the push-pull output tubes. The return from the cathodes of those tubes goes to the ground bus through the grid bias resistor, R-11.

This line is shunted by the two filter condensers, C-12 and C-21, drawn just left to the rectifier and which constitute part of the filter. There are no choke coils or other inductances in this filter.

Tracing from the tube filament down, and then left past C-12 and C-21, shows another d.c. branch running to the tapped voltage divider, R-14, and through that resistance to the ground bus. The full voltage output of the rectifier is therefore connected across R-14; suitable fractions of that voltage are tapped to supply other requirements of Fig. 2 and associated external circuits.

The first tap from the bottom of the voltage divider is connected to a line running left, which leaves Fig. 2 at the terminal marked "plate" and supplies "B" power to the external volume control amplifier. A further extension of the same line excites the photoelectric cells. This line is given additional filtering in the form of C-11, 20 microfarads, left of the voltage divider.

Left of C-11 and left of the meter switch a line runs upward through the 55-ohm meter resistor, R-15, and then divides. The right-hand section contacts one stud of the meter switch and continues upward through R-9 to the plate and two right-hand grids of the middle tube. The grids connected to the plate as shown serve merely as physical extensions of the plate — the tube is being used as a triode. The return from cathode reaches the ground bus through the grid bias resistor R-8.

Returning to the upper terminal of meter resistor R-15, trace upward through R-5 to the plate of the left-hand tube. The return from cathode runs through R-2 and R-3. The latter can be "shorted" out, reducing volume, when circumstances of the installation so require. The screen grid of this tube, which is wired as a pentode, receives its voltage from the line just traced, through the 2-megohm resistor R-4.

The central tap of the voltage divider may be traced upward to the screen grids of the two output tubes. The top tap is connected with the center tap of the power transformer filament secondary. The filaments of the tubes are therefore kept at a voltage as nearly as possible the same above ground as the cathodes. Potential difference between cathode and filament in these

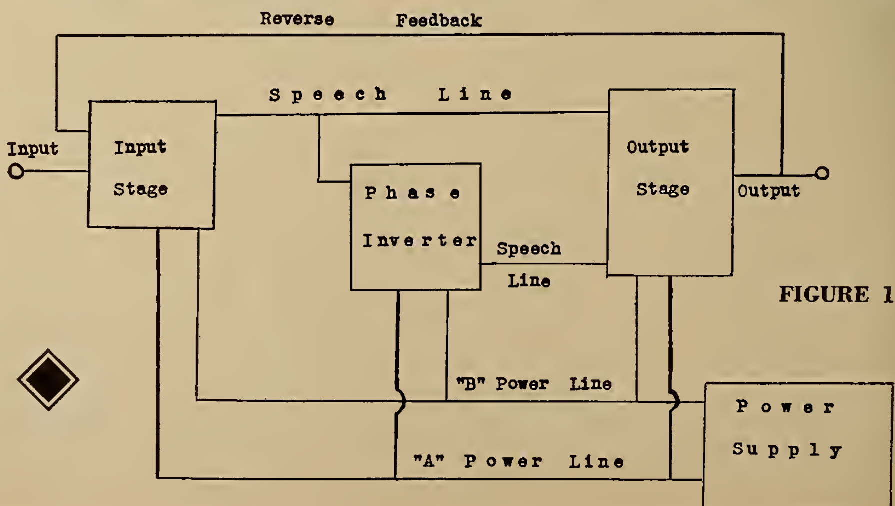


FIGURE 1

heater tubes is thus minimized, and a.c. hum is reduced. The arrangement is also a protective measure, since without it temporary potential differences of moderately high value might appear at full volume between the cathode and filament in those tubes and puncture the thin insulating sheath.

● Meter Circuits of Fig. 2

When the switch of the plate current milliammeter, at bottom center of the drawing, is thrown to the left, the voltage drop existing across R-15, 55 ohms, causes current to flow through the meter coil, producing a deflection. All the current drawn by the plate and screen grid of the left-hand tube, plus the plate current of the middle tube, must pass through R-15. The voltage drop through R-15, and the resultant meter deflection, must therefore correspond with the space current of the two left-hand tubes, and the meter can be calibrated accordingly.

When the switch is thrown to the right, the meter is connected across R-11, the grid bias resistor of the output tubes. The 30,000-ohm resistor, R-12, is placed in series with the meter to keep the meter current down to a suitable value. All the space current of the two output tubes finds its way to ground through R-11, and the meter is calibrated to show that current value.

All the tubes of Fig. 2 are self-biased, all the cathodes being elevated above ground potential by the extent of the voltage drop through their respective cathode resistors, and all the control grids are returned to the grounded input shield, thereby keeping them more negative than their cathodes. It should help avoid some possible confusion with some of the more novel speech circuit arrangements to glance briefly now at these grid bias connections.

From the left-hand grid of the left-hand tube trace left and down to ground through R-1 and the input shield. The cathode of the same tube is kept above ground potential by the voltage drop through R-2 and R-3.

The grid of the central tube goes to the input shield through R-7; the grid of the upper output tube through R-7 and R-6, and the grid of the lower output tube through R-10. The arrangements thus far traced show no striking novelties, a number of which, however, will be encountered in the speech circuits.

● Speech Circuits of Fig. 2

Speech input enters through the upper left-hand terminals of the drawing, completing its circuit through R-1 and C-1. C-2 can be added in parallel to C-1, where required, to improve low-frequency response.

The a.c. voltage drop across R-1 can be traced to the control grid and cathode of the left-hand tube. The corresponding speech a.c. generated between plate and cathode of the same tube can be traced from cathode to ground, and from plate to the right and down through R-5, down through R-15, right and up through C-11 (20 microfarads) to ground.

Several parallel circuits exist. One may be traced from the plate of the left-hand tube through C-5 to the control grid of the upper output tube. Another runs to the right through C-5 and down through R-6 to the control grid of the middle tube. In each case, the other side of the circuit is along the ground bus to cathode.

The plate or output circuit of the middle tube runs down through R-9, left and down through R-15, right and up through C-11 to ground; with a branch right through C-6 to the grid of the lower output tube.

The middle tube, therefore, is a phase inverter. It does not add volume. Its amplification is offset by the intentional reduction of its input voltage. Note that its input grid is connected between R-6 and R-7, which resistors between them constitute a voltage divider of 575,000 ohms. The input to the middle tube is only the voltage drop across

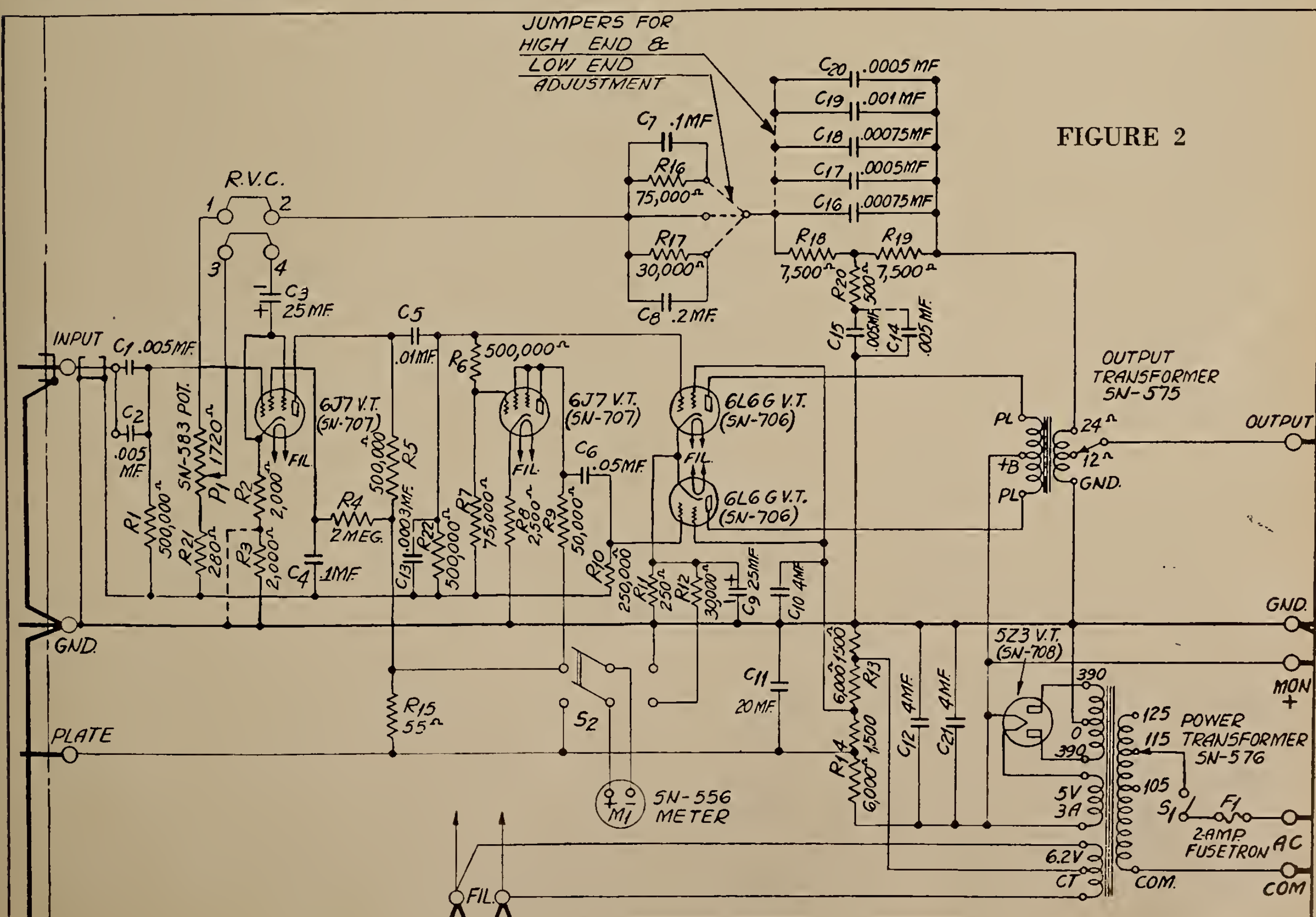


FIGURE 2

75,000 ohms of that resistance. These values are so chosen that the plate output of the middle tube will be equal in volume to the plate output of the left-hand tube. Thus, both grids of the output stage receive the same degree of excitation, or "swing," as they should for matched push-pull operation; but they swing 180 degrees out of phase with each other, or in "push-pull."

The sole purpose of the middle tube is to produce this phase shift between the input to the upper output tube and the input to the lower output tube. The output a.c. of an amplifying tube being 180 degrees out of phase with the input, introduction of a stage of amplification ahead of the lower output tube produces the effect desired, provided that the stage of amplification thus added is not allowed to amplify; more strictly, that its amplification be counteracted, as, for example, by the means just described, in order to keep the input to both push-pull tubes equal in voltage.

A very similar arrangement was diagrammed and traced on pages 13 and 14 of I. P. for August, 1936. Where this method of coupling single-ended amplification to push-pull amplification is not used, a coupling transformer must be substituted to achieve the same result—as, for example, in I. P. for December, 1936, page 23.

The push-pull stage speech circuit to the primary of the output transformer is entirely conventional, return to ground being through the center tap, straight down, and left and up through the filter condensers C-12 and C-21.

The output transformer secondary is tapped for 12- or 24-ohm speaker load, permitting variation of speaker arrangements according to the size of the system or the acoustics of the theatre.

● Reverse Feedback Circuit

From the upper terminal of the output transformer secondary a portion of the output power is fed back through a voltage divider consisting of R-19 and R-20, thence down through C-14 and C-15 to ground. A parallel voltage divider is created by the condensers C-16 to C-20, in association with R-18 resistor. This complex voltage divider thus incorporates the features of a high-pass filter, which can be adjusted by the condenser strapping arrangements. The adjustment chosen will govern the division of high-frequency voltages between the ground return by way of C-14 and C-15, or the alternative ground return by means of the wire running left and downward through P-1.

The low-pass filter is just to the left of the one examined. It is equipped with a three-position jumper which, when set at central position, eliminates the low-frequency filter entirely; but, when set downward, introduces low-frequency attenuation, and still more when set upward. These filters control the frequency response of the amplifier by reason of their effect upon the reverse feedback voltage.

The portion of that voltage which is permitted to pass through these filters continues to ground through potentiometer P-1, where any desired percentage of it is tapped off by means of the slider. The slider connects through C-3 to the cathode of the tube, incidentally picking up the suppressor-grid-cathode connection on the way. The reverse feedback voltage drop between the slider of P-1 and ground is therefore connected directly in parallel to the grid bias voltage of the left-hand tube. It has the effect of modifying the grid bias with a signal input that is 180 degrees out of phase with the normal signal input to the control grid of the same tube.

Reverse feedback, therefore, reduces volume by cancelling some of it. The extent of this cancellation with reference to different frequencies is governed by the setting of the filters in the reverse feedback line.

The primary and most important purpose of reverse feedback is, of course, to cancel harmonic distortion introduced into the sound by the slightly imperfect functioning inherent in all amplifying tubes. The distortion arises out of the fact that tube amplification is only nearly the same at different changes of input voltages; never exactly the same. Since the signal is either a.c. or pulsating d.c. the degree to which it is amplified undergoes a constant small fluctuation as the input voltage rises and falls.

The distortion thus introduced is, in a good amplifier, only a small percentage of the total output volume, but it can be heard and makes sound seem just a bit unnatural. To reduce this effect, a very small part of the output voltage is tapped off, and led back to the input 180° out of phase with the input. In this way the identical distortion is introduced into the signal in the proper phase relation to cancel the effect of imperfect amplifying action. Volume, of course, is also reduced to greater or less extent, being similarly opposed by this second input exactly opposite in phase to the original. Some of the details of this arrangement, which is becoming increasingly common, were discussed in I. P. for November, 1936, page 21.

The condenser, C-3, just above the left-hand tube, is of 25 microfarads capacitance, and has no filtering action of great importance. The lowest frequencies will pass through so large a capacitance practically as well as the high ones. It is introduced to keep P-1 from forming circuit around the d.c. grid bias voltage of the tube, with the possible introduction of noise when the slider is moved. The numbered "R. V. C." terminals make possible connection of an external potentiometer in place of P-1, by means of which the reverse feedback circuit can be used for —R. V. C.—remote volume control.

When a trouble has been run down to some one unit of the system (as by the quick-analysis methods suggested in last month's installment of this series) the next requirement is to apply the same sort of fast diagnosis to the interior of the unit in question. Hence, Fig. 1, which may be considered an *internal block* schematic diagram, performs a function similar to that of the system block schematic shown on page 21 of I. P. for April, 1938.

Thus, suppose complete sound outage has been traced to the amplifier now under consideration. What would be the fastest possible method of internal investigation?

Figure 1, mentally present to the trouble-shooter, shows that the difficulty may lie in any of the four portions of the amplifier, or in the connecting wiring between those sections. An instantly helpful clue is offered by the meter, which is the most plainly visible

Test Your *Craftsmanship and Win Valuable Prizes in This Question and Answer Contest*

Appended to each article by Aaron Nadell are four questions for the best answers to which four awards are made each month. The Contest is open to any subscriber to I. P. who is engaged in practical projection work. Awards are made on one basis only—the best answers; manner of presentation counts for nothing. Also, the names of those whose answers average fifty per cent correct or better are published.

All answers must reach I. P. not later than the 1st of each month. The judges are Mr. Nadell and the editor of I. P. In case of a tie, identical awards are made. Last month there were nine awards. Prizes awarded include valuable accessories useful on or off the job. At the end of six months a grand prize will be awarded for the best single gruop of answers submitted during that period. Apart from the awards, the Contest is excellent practice and provides an excellent opportunity to test your knowledge of the art.

component. Suppose the meter shows no reading. Then the place to begin internal investigations is in that portion of the parts and wiring designated in Fig. 1 as "power supply." There is no need to go into the complex structure of the entire amplifier.

On the other hand, suppose the meter shows normal readings in both positions of its switch. Then the power supply part of the unit is eliminated from further consideration, and investigation of the speech circuits is in order. Or if the meter shows full reading in right-hand switch position, and zero when the switch is shown left (Fig. 2), it is unlikely that any of the four rectangles of Fig. 1 will need investigation—the trouble almost surely will be in the "B" power line. This is easily found in Fig. 2: it runs right across the bottom of the drawing to the lower tap of R-14. (Of course, if the two left-hand tubes are not lit, then the "A" power line will be investigated instead).

Speech circuit troubles, as checked, for example, with headphones, are also found most readily through continuous mental reference to Fig. 1. Thus in case of complete sound outage, with filament and meter indications normal, the block schematic suggests that the phase inverter and all its components can be ignored, since no fault there except complete short-circuit across its input will occasion total loss of sound.

The process of elimination may begin by checking the output of the input stage, as by placing high-resistance phones across R-5 of Fig. 2. If no sound is heard, the remote possibility of reverse feedback complication can be removed by opening the remote feedback line, as at R. V. C. point No. 1. If the phones still remain quiet, only the input stage can be at fault, and short-circuit of R-1 suggests itself immediately as the most promising possibility.

Thus Fig. 1 guides the investigator step-by-step through a very few tests that result in localizing the trouble, almost in less time than it takes to read this paragraph. Not that every case of trouble will prove equally simple, but that the more complex the symptoms of trouble appear to be, the greater the value of instant mental reference to a diagram such as that shown in Fig. 1.

Here are the Contest Questions—

NOTE: Answers should be predicated on the diagrams accompanying this article and not on contestants' own equipment.

21. Complete loss of sound has been traced to Fig. 2. Headphones show somewhat lowered volume across R-5, lowered volume across the primary of the output transformer. What would you do?

22. The tube in the upper socket of the push-pull pair of Fig. 2 burns out often, stopping sound entirely. Between burn outs meter fluctuation is noted when the meter switch is thrown to the right. What would you do?

23. With the low-frequency filter strap of Fig. 2 set at maximum l. f. volume (center position), low-frequency response increases suddenly. The effect can be heard with headphones across R-5, but sound across R-1 is normal. What would you do?

24. In a case of complete sound outage in Fig. 2, headphones show somewhat increased volume across R-5, no sound across the primary of the output transformer. All filaments light, meter reads normally, and all socket voltages check normally. What would you do?

Contest Answers; Borgeson Tops Field

FOR the second consecutive time no individual contestant turned in a group of answers that merited publication in toto, thus we again present answers to the four questions by as many contestants. Projectionists, it seems, are specialists in one, maybe two, phases of the art, because some of the boys who can step up and practically "murder" a rather involved question involving electronic theory fail miserably on a query relating to that which is commonplace in everyday procedure.

The list of winners this month is proof conclusive that those fellows who have been having a field day while the questions dealt mainly with theory are in for some rough going now that the Contest has taken a more practical twist. Those who have been delving into and doping out and worrying about sound pictures since 1928 or thereabouts, fellows who consider themselves "straight projection men," are now getting their licks in. The winners:

First Award
LAWRENCE BORGESON
454 El Molino Ave., Pasadena, Calif.

Second Award
EVERETT RENFROE
4633 So. Wabash Ave., Chicago, Ill.

Third Award
J. T. KIRKHAM
2508 1st St., S.E., Calgary, Can.

Fourth Award
H. D. TAYLOR
705 W. South St., Raleigh, N. C.

Borgeson's paper as a whole clearly merited first place; but the other three winners were so closely grouped as to make exceedingly difficult their proper grading. For example, Taylor "killed" two of the questions, but tapered off sharply on the other two. George Wilde, of Columbia, Ill., and C. L. Cromer, of New Brookland, S. C., missed placing by the proverbial hair. The winning answers:

13. Where would you look for trouble if there were no sound, and a mercury vapor rectifying tube showed a lit filament but failed to show a blue glow?

By H. D. TAYLOR

There are several types of mercury or gas rectifying tubes. Those designed to rectify heavy currents are mostly single- or half-wave rectifiers and are used in projection room sound systems in full-wave pairs to rectify a.c. for speaker fields, exciter lamp circuits, *etc.*

Since the failure of a single rectifier occasions complete loss of sound, the tube referred to here evidently is a full-wave mercury rectifier used to supply relatively small currents at high voltages for amplifier tubes, which are of the hot-cathode type.

Here the heat of the filament partially vaporizes the mercury, creating a mercury gas. Ionization of this gas, visible as a bluish glow between the cathode and plate, occurs when the positive voltage applied to the plate is sufficient to impart to the electrons emitted by the plate sufficient velocity or speed to break up the gas atoms, or molecules, thus separating their positive and negative charges, or ions.

The effect of this ionization is to reduce the internal resistance of the tube by cancellation of the space charge, thus increasing the electron flow across the tube, which in turn increases the current-carrying capacity or rectification of a tube of given size, or at a given plate voltage.

If the amplifier be properly turned on with no sound and no glow in a mercury rectifier known to be good, though the filament appears to be lit o.k., there is a possibility of an open- or short-circuit somewhere in the d.c. circuit or its associated filter or load in series with the output of the tube. If the continuity of the plate-cathode circuit is broken, there will be no current flow across the tube, although the invisible mercury vapor, or gas, still will be present.

The fact that the filament is lighted clears the power transformer primary and the filament secondary windings. If one side of the plate secondary or circuit is open, there still will be a circuit between the cathode and the plate of the other side of the winding, and there will be a glow on one side of the tube. There being no glow about either side of the tube, the plate secondary and circuit should be tested for an open- or short-circuit.

If there are fuses in the plate circuit, they should be checked; if there are none, or if they are o.k., the a.c. voltage across the windings should be checked. If the voltage is normal, the filter circuit, chokes, resistors, *etc.*, that are in series with the

(*Continued on page* 32)

Enlarging The Visual Field of The Motion Picture†

THE first step toward making pictures lifelike was to add the effect of motion. Then sound was added; and now natural color has become a factor necessary to enhance the effect of realism of the motion picture. There still are to be considered, however, two more elements required to render the picturc completely lifelike.

The first of these, that of obtaining a sense of depth or relief, is occupying the minds of many at the present time. The second is an important factor that has not received sufficient attention in the past—that is, making the picture appear to fill the field of view of the spectator in the theatre, so that the spectator is no longer "picture conscious." Rather he should be made to feel that what is being unfolded before his eyes is very much the same as his natural field of vision in real life.

There are two reasons why this effect can not be achieved under the present conditions of motion picture projection. One is the limitation of size of screen and motion picture film; the other is the artificiality of the black border, which sharply cuts off the edges of the picture.

The motion picture screen as now presented occupies only a small portion of the field of vision of the spectator sitting in the theatre. Surrounding the screen is not only the black masking but also wall and ceiling surfaces unrelated to the picture, the illumination levels of which are disconcerting to the viewer and irrevelant to the illumination of the screen.

● Effective Area Reduced

The artificiality of the present screen surroundings is further emphasized in the presentation of color pictures by the sharp contrast of the gray and black surroundings against the strong colors of the screen. In the case of black-and-white pictures, at least the black of the surroundings has some relation to the blacks or grays on the screen, although the intensities of the light on the surroundings and the screen vary to a disturbing degree.

These present unnatural screen surroundings have had the effect of establishing a kind of cinematography that is most inflexible and limited in scope.

By B. SCHLANGER

Consulting Architect, N. Y. City

Recent trends toward the smaller sized motion picture audience indicate that new considerations can be given to the possibility of a larger and differently shaped screen, retaining the 35 mm. film. The screen is pictured as completely occupying the entire forefront of the motion picture auditorium, assuming a space stage instead of an artificially framed picture.

For example, the black border around the screen has a tendency to force the use of pictures having low lighting intensities at the marginal areas, to avoid glaring contrasts at the border lines. Another example of the limits imposed is the hesitancy to place images or objects of human features near the sharp cut-off borders because of the unnatural effect of splitting the images.

This hesitancy to use the marginal areas of the screen for various light intensities and image placements has resulted in reducing the effective area of the screen for action portrayal. This is most unfortunate when it is realized that the working screen area is not any too large for other than close-up shots.

There are two suggested means by which this artificial limitation may be eliminated and a more lifelike projected picture be achieved. One is to project an enlarged picture upon a screen occupying a substantial portion of the spectator's field of vision. The other is to create an area contiguously surrounding the present screen, upon which a lighting effect can be imposed matching as nearly as possible the lighting occurring in the marginal areas of the picture.

The first method apparently can not be utilized at this time, due to limitations of the 35 mm. film and the present projection and optical system, besides the difficulties encountered in the costs of producing larger settings to fill the larger screen, of which portions would naturally have to be subdued to the main focal interest.

The second means suggested would not require any change in the film width or in the screen size. The desired effect can be attained at and around the screen. Many attempts have been made in the past to create an illuminated field in line with or forward of the screen. These have all been unsuccessful because the source of illumination used was secondary, utilizing indirect lighting troughs around the picture.

Although some attempts were made

FIGURE 1 ***Present form of screen picture, with jet black border surrounding the image***

†J. Soc. Mot. Pict. Eng., XXX (May, 1938), No. 5.

to vary the color and intensity of the light, it was practically impossible to create automatically colors and light intensities that would match the ever-changing colors and intensities occurring in the marginal areas of the picture. It is evident that a screen-border illumination of a fixed intensity and color can prove to be just as artificial and frame-creating as the present black border when the marginal areas of the picture are dark compared with the contiguous illuminated border.

An illuminated field contiguous to the screen proper must not only have a constantly changing intensity of light and color, but its light and color must also vary along the four sides of the screen to match and blend the various edge conditions of the picture into the surrounding field.

Figure 1 shows a picture with the conventional black border. Fig. 2 shows the same picture with a contiguously surrounding field, having on it the various intensities nearly corresponding to the intensities existing on the picture margins. The various marginal light intensities have to blend into the background field illumination to render the physical edge of the screen as indefinite as possible.

To meet the problems herein discussed, a system* devised by J. Gilston and the author will be demonstrated for the first time in conjunction with the presentation of this paper. The system utilizes the principle of employing the projection light-beam to create an illuminated field contiguous to the picture edges. It achieves the desired result of synchronizing, automatically and with great simplicity, the color and intensity of light of the marginal areas of the picture with the color and light intensity of the surrounding field.

*U. S. Patent

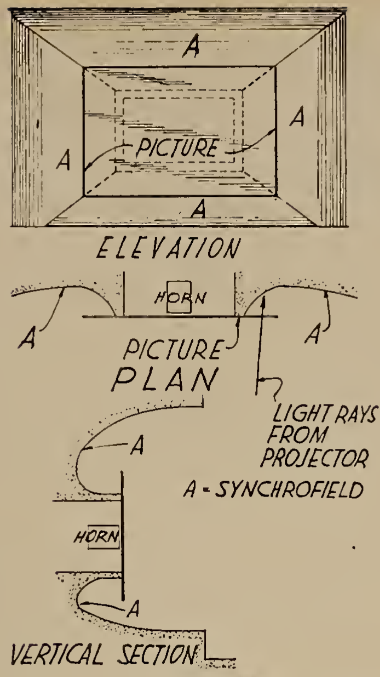


FIGURE 3

Diagram of the screen synchrofield

Fig. 3 is a diagram of the screen and the arrangement of diffusing and reflecting surfaces forming a "screen synchrofield." The light falling from the projector upon the marginal areas of the screen is transmitted through the marginal areas of the screen upon the diffusing and reflecting surfaces behind and beyond the screen edges. Since the lighting of the screen marginal areas and the lighting of the surrounding field have but one source, the necessary blending of the picture edge into the surrounding field is assured. No attempt is made to create upon the extended field any definition or duplication of forms occurring on the screen marginal areas. The extended field appears to have vague extensions of the color and light intensities of the screen marginal areas, thus simulating the effect of peripheral vision in real life.

FIGURE 2

Screen Synchrofield, showing luminous vignetting around the image

Elimination of the limiting artificial screen surroundings would help the spectator to connect himself more intimately with the space enfolded by the screen. The side walls of the motion picture theatre auditorium can now be made to blend into the "screen synchrofield" surfaces, thereby making it further possible to "project" the spectator into the scene of action. For successful results, the walls must be designed to reject or receive light reflections from the screen to a proper degree. Secondary lighting must be completely eliminated from any of the auditorium surfaces at or near the screen, allowing only the carefully studied use of the screen lighting to control the lighting of the forepart of the theatre.

Another advantage of this procedure is the elimination of eye fatigue caused by the necessity for adjusting the eyes to accommodate the sharp contrast of the black border and the illuminated screen. Indirectly, eye fatigue will also be reduced further, inasmuch as brighter levels of screen illumination may be used for improving visual acuity without the disadvantages of the glare created by high brightness levels within dark surroundings.

The new and greater possibilities in cinematographic expression and new screen brightness evaluations resulting from the use of the "synchrofield" seem most encouraging. Eliminating the definite edge of the picture will, in effect, increase the effective area of the screen, since a freer use of the marginal areas of the screen for image placement will be possible.

Panoramic views will be greatly enhanced by the apparent extension of the sky and nature's forms. The use of colored films will also be greatly enhanced by the elimination of the black surroundings that lend artificial hardness to the picture. Brilliant colors on the picture proper will appear softer when brilliant colors in subdued degree appear in the peripheral screen surroundings. Achievement of actual depth effects in the projected motion picture will further demand the elimination of a sharp picture cut-off.

DISCUSSION:

MR. KELLOGG: How does the reflectivity of your translucent screen compare with that of a piece of white paper?

MR. SCHLANGER: There is no doubt that

(*Continued on page* 31)

A New Arc Aligning Method: The Bantau 'Theaomai'

By *KNEELAND NUNAN*

MEMBER, PROJECTIONIST LOCAL UNION 150, LOS ANGELES, CALIFORNIA

Accompanying this article was a note from the author stating that, although the Theaomai has been used for several years with excellent results, Mr. Bantau, who developed it, has sought no patent protection on the device, in fact, has not even copyrighted the name. Its use is unrestricted. The average projectionist, lacking suitable facilities for assembling the Theaomai, would benefit by quantity production of this device by some progressive manufacturer.—*Editor.*

MANY individuals engaged in the field of motion picture projection occasionally are smitten with an idea. Generally, the idea is not developed, often not even discussed, to the ultimate loss of the person who initiated it. Consequently, it is deserving of notice when a man not only has an idea, but develops it. The man is A. F. Bantau of I. A. Local Union 150, Los Angeles, California; and his idea has flowered into a device which he calls "Theaomai." The "Theaomai" is known to comparatively few of his colleagues, and for this reason the writer asked for and received his permission to tell the craft of its design and utility.

Theaomai is from the Greek, meaning "I see." Accordingly, one may assume that the instrument has to do with the optical alignment of projection apparatus. This is an old problem, and it has been solved in a variety of ways with a variety of results. Many projectionists have set up their equipment as closely as possible to the standards laid down by a particular manufacturer, and by trail-and-error have shoved their lamphouses back and forth, set and reset their arc adjustments, and fiddled and fussed with their condensers or mirrors until they attained what to them were optimum screen results.

Others have used an aligning rod which was inserted through the lens holder and aperture. The rod was held in position by machined pieces that fit in the holder and the aperture. The end of the rod was turned to a point to indicate the true center of the optical system. This point was made to coincide with the true center of the condensers or mirror. The carbons were aligned empirically. There are still other methods.

FIG. 2. *Shelby tubing barrel, 12 to 18" long, with cross-hairs*

The writer does not find fault with these methods; he merely wishes to tell of another. When one thinks of a lens, of a condenser, or of a mirror, one thinks of Precision—with a capital P. Therefore, if one is to obtain optimum

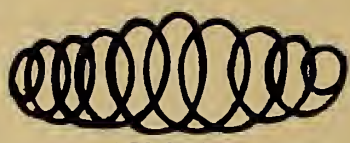


FIGURE 1
Conical spring tension springs

results from his optical system, the alignment must be precise. Optical methods may here be applied. A. F. Bantau's Theaomai is just that—the application of optical methods for the precise alignment of the heart of projection equipment, the optical system!

What is the Theaomai?

The Theaomai adapts the theory of the transit in place of the aligning rod. The sight tube of the transit in this case is made of Shelby tubing of 5/16 inch outside diameter and 12 to 18 inches in length. Cross-hairs are located ½ inch back in the tube. Obviously the sight tube must be very straight, and Bantau insured this condition by placing it between lathe centers and grinding and polishing to a diameter of 0.312 inch.

It is held in the true optical center of the lens and aperture by a method so unique that it makes the application of the instrument universal for any size lens. The optical elements of the lens are removed, and the lens barrel replaced in the holder. An aluminum cone (illustrated in Figs. 5, 6, and 7) is slipped over the tube and flush with the lens barrel. The tube is held from the aperture end by an inverse plug that fits from the lamp side of the aperture plate.

The plug is shown in Fig. 9, and the round brass nut which is threaded to fit the tapered and slit threads of the plug is shown in Fig. 8. The aperture plug is fastened to the sight tube by means of the brass nut, which squeezes the plug fast by action of the tapered threads. So far the tube is held fast on only one end. Fig. 1 shows a conical spiral tension spring. This spring is slipped over the tubing and flush with the aluminum cone, and the split clamping ring from Fig. 3 is slipped into place and clamped by means of the screw shown. Bantau says: "The spring should be of about 15 or 18 coils and about No. 18 steel or music wire, and it should not exert a pressure of more than 4 pounds over the entire surface. Each end should be ground flat, so as to fit even all around."

The eye-piece is made of brass, painted inside with lampblack, and made to slip snugly over the end of the Shelby or sight tube. It is shown in detail in Fig. 4. It is interesting to note that it was lapped to fit on the barrel tube in preference to the use of reamers.

Operation of the Theaomai

Assume that the instrument is now in place and ready for operation. Let us consider first a high-intensity lamp. Obtain two pieces of tin the exact size of the condensers and find their precise centers. Drill these centers with about a No. 40 drill. Place that piece of tin comparable to the front condenser in the position usually occupied by that

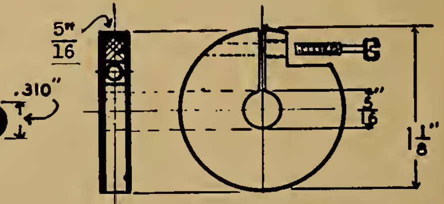


FIG. 3. *Split clamping ring*

unit. Bring the center of the tin into alignment with the cross-hairs of the instrument by the usual methods. Re-

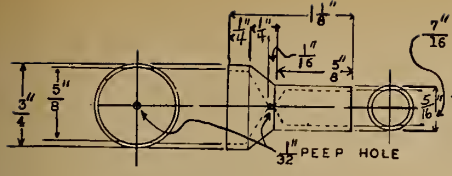


FIGURE 4
Brass eye-shield

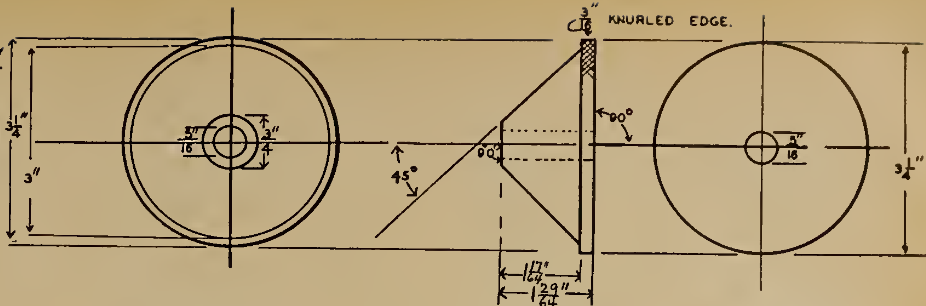


FIGURE 5
Front elevation

FIGURE 6
Front elev. of aluminum cone, lens center

FIGURE 7
Rear elevation

moving the first piece of tin, place the second piece of tin comparable to the second condenser in the position usually occupied by that unit. The center should align without any adjustment; if it does not, a slight lateral adjustment will bring the center into position.

Now replace the first piece of tin, and when a clear line of vision is obtained the condensers are not only aligned for centers, but the plane of the condensers will be perpendicular to the optical axis about the horizontal. If the plane of the condensers is found to be not perpendicular to the optical axis about the vertical, the front or rear of the lamphouse will have to be either raised or lowered, whichever suits the condition.

Obtain a piece of tubing the outside diameter of which is the same as that of the positive carbon of the lamp. Place cross-hairs at both ends in a manner to be outlined hereinafter. With the positive carbon replaced by the tubing, make the required adjustments to bring the two sets of cross-hairs into coincidence with the cross-hairs of the sight tube as seen through the eye-piece. The crater of the positive carbon will now burn perpendicularly to the plane of the rear condenser, assuming the negative carbon to be aligned properly. If the lamp is of the straight-arc type, the procedure is the same except that the crater is aligned empirically.

The second consideration is that of the mirror-type of arc lamp. The manufacturer aligns this type of lamp at the factory so that the positive element faces the optical center of the mirror, therefore the alignment is relatively simple.

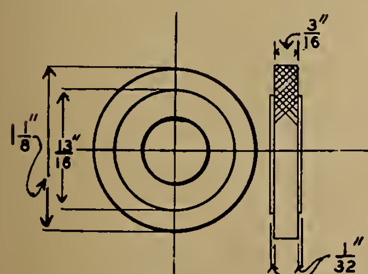


FIGURE 8
Round brass nut knurled and threaded to fit threads in Fig. 9

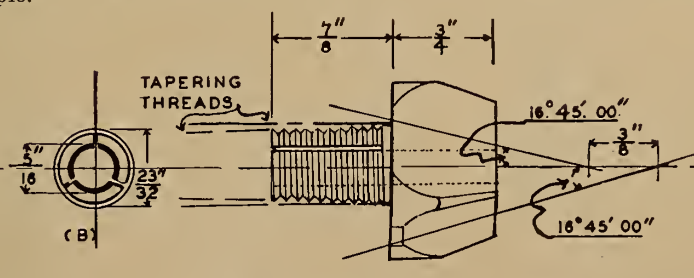


FIGURE 9
Brass center for aperture plate

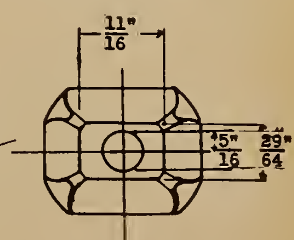


FIGURE 10
Aperture end elevation of Fig. 9

The positive carbon is replaced by a tube, the nature of which has already been considered. The required adjustments are made to bring the centers of the tube into coincidence with the cross-hairs as seen through the eye-piece.

To those who would like to build the Theaomai Bantau offers some pertinent suggestions. Careful attention should be given to certain phases of its construction.

Construction Tips

1. The conical spring is used because when compressed it will occupy a space about ⅝ inch.

2. A 12-inch length for the Shelby tubing barrel is ordinarily sufficient. The cross-hairs should be about 0.010 inch diameter, stretched taut and then soldered, and all the solder scraped from the outside of the tube. The holes for the cross-hairs should not be larger than 1/32 inch. The size of the tube when finished should be 0.310 inch, tolerance plus 0.002 inch, minus 0.000 inch.

3. The split clamping ring, made of brass, is slit from one edge to the 5/16 inch hole in the center, with an 8-32 machine screw tapped into one side to clamp on the tube to hold the tension spring.

4. The eye-piece, made of brass, should be painted inside with lampblack after it is finished, and should slip on the tube just snug. Drills used should be checked and ground to 59°, to insure proper angles and hold well centered. The eye-piece should be lapped to fit the barrel tube in preference to using reamers. The 5/16-inch hole has a tolerance of minus 0.002 inch, plus 0.000 inch.

5. The aluminum cone to be used for the lens center is to be cut at 45° to the axis of the 5/16-inch hole in the center, and to have a knurled edge to prevent dropping.

6. Figure 6 shows a general elevation of the cone with the angle of 45° and the knurled edged, also the length of the cone. This cone to be made of aluminum as free as possible of any air bubbles.

7. Figure 7 shows the rear side of the cone, the 5/16-inch hole to have tolerance of minus 0.002 inch, plus 0.000 inch.

8. The nut used to clamp the split threaded part of Fig. 9 on the barrel tube is to be made of brass 1⅛ inch in diameter and threaded with tapered threads; the taper should be about 1/16 inch per inch. The threads should be from 16 to 18 to the inch.

9. The center for the aperture, or plug, may be rounded or beveled to permit use on round cornered apertures. The angles 16° 45′ which intersect the axis of the system ⅜ inch apart are so designed to create a snug fit over the entire aperture.

10. Careful study should be made of the aperture end elevation before this part is turned out (Figs. 9, 9B and 10). The 5/16″ hole must have a tolerance minus 0.002 inch, plus 0.000 inch. When Figs. 4, 6, and 9 are completed, they should be lapped with grinding compound on the tube in preference to the use of reamers to secure a snug fit—allowing a clearance of 0.002 inch to prevent any looseness on the tube. These parts should work on the tube with very little effort.

NOTE: This entire device should be

(*Continued on page* 30)

Notes From the Supply Field

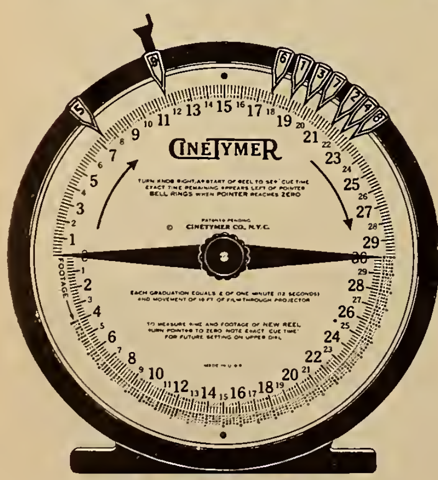
NEW and novel is the Cinetymer which not only measures each reel exactly and times the show accurately but also gives a warning for the changeover at precisely the right time. Device, shown here, employs a clock that requires only a single twist to wind. Can be mounted anywhere in projection room (not for mechanism mounting) or may be set up on a flat surface.

Pertinent facts anent Cinteymer: gives audible *and* visible changeover signal as well as film length and running time, all in one combination. Gives exact timing for pictures, non-sync. music, acts and many other purposes. Renders unnecessary hazardous practices, such as opening magazine door; painting film edge with metallic paint to actuate circuit; use of metal near reel end to produce clatter when it drops; special punch marks, and eliminates complicated cell or relay attachments which signal reel end but do not signal arc warm-up time.

Operation: At start of reel, turn knob to *right* till pointer reacher *zero. Time* and *footage* of reel appears on *lower* dial. When *end* of reel is reached, pointer on *lower* dial indicates running time. Give to *each* succeeding reel a *consecutive* number. *Correspondingly* numbered markers placed over upper rim, point to *exact* running time for each reel and *remain* in place during *entire* show. Mark assigned reel numbers on *film containers.*

Projectionist decides on time required for audible signal, before cue-dot appears on screen. Set pointer the *desired* number of seconds, to *left* of marker designating reel just starting, to allow for striking arc and preparing for changeover following ringing of bell.

The remaining time to end of reel will always show at *left* of pointer. Move indicator until arrow points to numbered



Showing the new Cinetymer

marker of reel then running. After *each* changeover promptly set pointer and move indicator to next numbered marker.

Turning of pointer and indicator are *the only operations* required.

NOTE: With exact reel footage *previously* known, calculator on lower dial tells running time.

Example for Typical Show

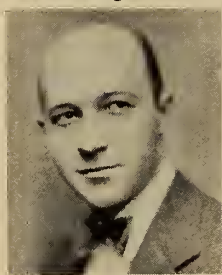
	Reel	*Minutes*
Feature	1	18.8
"	2	21.5
"	3	19.6
"	4	22.2
"	5	7.4
Comedy	6	17.7
"	7	20.4
Musical	8	22.8
News & Trailer	9	11.6
Non-synchronous	—	4.3
		166.3

Feature runs 89.5 minutes, complete program 2 hours, 46 minutes, 18 seconds.

Manufactured and distributed by Cinetymer Co., 837 Eleventh Ave., N. Y. City.

Meet J. D. Eagan, Gen. Mgr. of Wilmer & Vincent

Presented here with considerable pleasure is the likeness of Mr. J. D. Eagan, General Manager of the Wilmer & Vincent theatre circuit, who, to come to the point quickly, not only is aware of the extreme importance of projection to the successful operation of theatres but also is keenly aware of what to do to promote employee goodwill and obtain maximum efficiency. Why? Well, incline an ear and we'll tell you.



J. D. Eagan

All Mr. Eagan did was to gather up the chief projectionist in each of his circuit's theatres and bundle them off to the recent S. M. P. E. Convention in Washington—with pay during the time they were absent and with the circuit paying all expenses! Were the projectionists of any other circuit present in Washington under similar circumstances? No! Has any other circuit ever done just this before? No!

Mr. Eagan, we salute you!

And now we suppose we'll have to name the lucky mugs who made the trip: Harry Jarvis and O. E. Bugg, Richmond, Va.; Frank Sutton and C. E. Comstock, Norfolk, Va.; from Penna.: Charles Brunner, Altoona; Charles Reed and P. F. Patterson, Harrisburg; L. Talbot and Merrill Young, Reading; Stewart and Charles Seifert, Easton; H. Conrad and L. Rau, Allentown; and Harry Behr, supervisor in N. Y.

MOTIOGRAPH K. C. AGENT

Ernest C. Leeves has been appointed Motiograph representative in the Kansas City, Mo., film trading area, handling both projector and sound system sales under firm name of Central Theatre Equip. Co. at 130 West 18th St. He will also handle Brenkert products. Leeves was formerly Erpi district manager in K. C.

NEW FILM CEMENT PEN

Intended to supplant the old bottle and brush combination, a film cement pen the use of which is indicative of its name is being distributed by Fisher Mfg. Co., 60 State St., Rochester, N. Y. Made by a practical projectionist, this pen controls the flow of cement by a mechanical plunger valve, which when closed is air-tight. One filling serves for 1,000 splices. Slight pressure on point allows flow of cement.

SETTLE STRONG C.-O. SUIT

Suit of Essannay Elec. Mfg. Co., makers of Strong Zipper changeover, against Balaban & Katz, theatre circuit of Chicago, on use of electric changeover asserted to infringe on L. D. Strong patents, has been settled out of court.

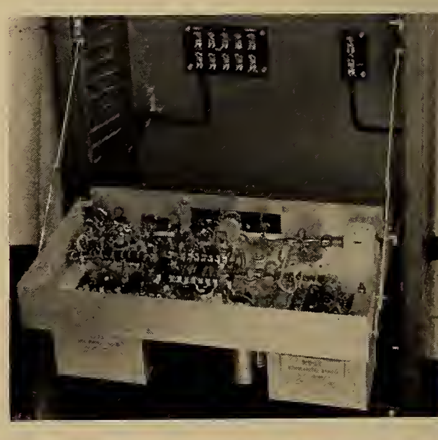
Altec Service Corp. has been awarded contract for maintaining transcription and other complex devices at more than 170 radio stations in the U. S., most of which are affiliated with World Broadcasting System.

NEW ERPI N. Y. ADDRESS

Final consolidation of all Erpi departments at 195 Broadway, N. Y. City, has been effected with the transfer of engineering, accounting, legal and foreign departments from former address at 250 West 57th St. Major portion of company's administrative functions made the change about a year ago.

New Academy Sound Book a Smash Hit; 2nd Edition Ready

Eight days after publication of the Academy's new book, "Motion Picture Sound Engineering," the first edition was sold out, with 400 orders still on file. A new edition has been ordered. This book, containing 551 pages and 381 illustrations, was prepared for the Academy Research Council by Hollywood studio experts and completely covers the subject of sound recording and reproducing. It is conceded by authorities to be the finest publication on sound pictures ever turned out. Now available at a special pre-publication price upon order direct to the Academy of M. P. Arts & Sciences, Taft Bldg., Hollywood.



Simplex sound system features 180° rotation of chassis, exposing all wiring and connections without interrupting operation

I. A. Meet Will Attract 900 Reps. From 706 Locals

MORE than 900 delegates representing 706 local unions will assemble in Cleveland on June 6 for the Thirty-Fourth Convention of the parent body, the I. A. T. S. E. & M. P. M. O. U. of the U. S. and Canada. Represented at the meeting will be delegates from every territory in the U. S. and Canada, from the Canal Zone, and, this year, from far-off Hawaii, where a local unit was recently chartered.

Official headquarters will be at the Hotel Hollenden, although the Convention sessions will be held in the magnificent $15,000,000 Municipal Auditorium. Although no election of officers is scheduled this year, all terms having been extended to four years at the last meeting in Kansas City, the forthcoming Convention will experience no lack of action. Doings since the last conclave will be reviewed; jurisdictional issues will be considered; battle lines for the

---

Those familiar with the motion picture theatre industry stress the importance of comprehensive examinations for prospective operators, to insure safety and health. Such examinations should be designed to test not only familiarity of projectionists with the State and city regulations that apply in his district, but above and beyond that to demonstrate his practical ability to show films, knowledge of film and machine repair, and training in general care of the apparatus.

future will be drawn, and numerous other subordinate matters will be mulled over no less in district meetings than in the Convention sessions.

● I.A.'s Future Prospects

I. A. membership now approaches the 50,000 mark, as contrasted with about 30,000 two years ago. This sensational advance has merely whetted the appetite of the I. A. to nail down all labor groups in the entertainment field, irrespective of classification. I. A. makes no secret of its yen in this direction; in fact, it broadcasts it to all and sundry at every opportunity.

Hollywood is now in the I. A. camp lock, stock and barrel. But I. A. wants even more, so it has blandly laid claim to jurisdiction over certain talent groups. I. A. now has all the exchange workers, all the theatre sound system servicemen, and all the laboratory people; yet it would surprise nobody who is well informed if they sought and got all theatre employees from the ticket sellers to the charwomen, not excluding the managers. Verily, I. A. is in the process of rearing a labor union empire.

Not the least important topic for consideration by the Convention is the commercial film situation. Two years ago this field consisted largely of industrial film showings, contact with which was rather easily maintained. Currently, however, there are not only several times the number of industrial units operating than in 1936, but there are innumerable small-town theatres using 16 mm. equipment. Rumors of the establishment shortly of a 16 mm. theatre circuit in towns not now having motion picture facilities are rife. Here, too, I. A. takes a firm stand: they want all film work, irrespective of film size, characteristics or quantity.

The status of television and its possible effect upon show business will likely be aired, although it is difficult to chart the course of such a discussion in view of the present muddled state of this baby art. Most of the gabbing thereon will be done in private rather than on the Convention floor.

No statement anent the course of the Convention having been forthcoming from responsible quarters, extended speculation thereon is fruitless. A detailed report of Convention happenings will appear in these pages next month.

New Arc Aligning Method: The Bantau 'Theaomai'

(Continued from page 27)

machined under Class Z specifications for fine tool work.

Nothing has been said herein concerning the distance at which the condensers or the mirrors should work from the film, or any other detail which is so important in obtaining a good field of illumination. Articles which have appeared in INTERNATIONAL PROJECTIONIST from time to time cover this field far more effectively than the writer could ever hope to do. The object of this paper has been to inform the craft of the activities of one of its members who unaided developed an instrument for precise measurements.

This instrument is of particular inter-

est at the moment, because the leading manufacturers have developed methods by which lamphouses may be adjusted in either a horizontal or vertical direction with ease. Conversely, inaccuracies inherent in older type lamps as regards lamphouse carriages and bases have been eliminated.

The Theaomai has been used with Bantau's permission at one of Hollywood's leading studios, and several of brother craftsmen have used it to excellent advantage. He has made a definite contribution to his craft.

Enlarging the Visual Field of the Motion Picture

(*Continued from page* 25)

we are losing some of the light through the translucency.

MR. KELLOGG: That is an indication of the price you pay in screen brightness.

MR. SCHLANGER: Where the incident light is the minimum possible, it would be necessary to increase the light upon the screen to compensate for the light transmitted through the screen. The screen material used in this model is not considered the most desirable, and further experimenting is necessary to determine the most efficient material.

MR. GOLDEN: Of what material is the field surrounding the screen?

MR. SCHLANGER: This happens to be a white diffusive paper. Ordinary plaster would be more suitable.

MR. KELLOGG: I was wondering whether you could not utilize some of the light reflected from the screen at angles too great to be useful for viewing the screen, say, inside of 45 degrees. I do not know whether there would be enough light reflected from the edges of the screen but it might be utilized, if sufficient, with less loss to the screen illumination, than to depend upon transmitted light.

MR. SCHLANGER: I have investigated the possibility very thoroughly, and dropped the idea because if we allow the light entering the central area to reflect to a surface at, say, 45 degrees, there will still be sharp contrast between the picture and the border. The purpose is to blend only the edge condition into the surrounding field.

The conception embodied in this scheme differs fundamentally from previous proposed solutions. Earlier attempts employed fixed border illumination, while this arrangement rests upon synchronizing the field lighting with that of the screen edge.

MR. RICHARDSON: I feel that when we put light outside the screen we detract from the picture.

MR. SCHLANGER: That is true when the source of light near the picture and within the field of vision of the spectator is unrelated to the picture. But it is not objectionable if the light that appears within the field of vision is gauged to the edge light of the picture. The field illumination in this scheme operates as an integral part of the scene being viewed, and therefore does not detract from the picture.

MR. GREENE: The light that passes through the edge of the screen and is reflected to the outer edges of the border should not be regarded as light outside the screen. Psychologically, the plaster surface becomes part of the screen. However, I wonder whether the area of the screen backed up by the theatre speakers will cause non-uniformity of illumination of the picture area; in other words, the dark central portion where the speakers are located might appear much darker than the border of the active screen represented by the reflective surface.

MR. SCHLANGER: The external marginal areas of the screen will not appear sufficiently brighter than the internal area, for two reasons: First, we know that the central area of the screen has a higher illumination level due to the optical system, and second, the reflectors are so designed as to reflect the light outwardly, rather than back to the screen again. This demonstration did not show a marked contrast between the marginal area that was being used and the central area.

MR. CRABTREE: I congratulate Mr. Schlanger on having done something about which many of us have merely been thinking. It seems to me that the effectiveness of this scheme will be a maximum at a certain critical distance from the screen. I always like to sit close to the screen, where the margins are least conspicuous. Farther back in the theatre, the margins become very objectionable, and the effectiveness of this arrangement, I should think, would be a minimum at the back of the theatre. Have you tried the effectiveness at various distances?

MR. SCHLANGER: Certainly for the major

portion of the theatre, where the range of vision takes in only the screen plus the synchrofield, the condition should be best. Farther back the angle of vision includes not only the screen and the synchrofield but some of the walls of the auditorium as well. To complete the idea, it would be necessary to continue the effective screen area still further, and, as stated in the paper, the auditorium walls and ceiling surfaces within the field of vision could be treated with a suitable quantity of light. The objection would then be overcome and the system would be effective for the complete depth of the theatre.

Mr. Crabtree: Would not this kaleidoscopic movement occurring around the screen be a little distracting? It would depend, of course, upon the general illumination level in the theatre.

Mr. Schlanger: If this scheme were shown on a full-size screen the synchronized light field would, we believe, occupy the peripheral vision of the spectator, and therefore the synchronized light movements would hold a more natural and undisturbing effect, similar to the vague feeling of peripheral movement felt in real life. In the past few years I have built quite a few theatres and have dared to leave the wall surfaces quite bright, some of them even of white plaster. There has been a feeling that auditoriums ought to be pitch black, but I have found that if the walls and ceilings are evenly illuminated (that is very important), with no interruptions of dark or light areas, an astonishingly high illumination level can be put upon the walls and ceiling without detracting from the picture.

On the other hand, in a darkroom with a picture being projected, as little as a 2-watt bulb behind a shield throwing a slight glimmer of light upon a dark area is very objectionable. What is required is an even bath of illumination over the complete surface, of an intensity that will blend from the screen lighting to your position in the auditorium. Objections to light in an auditorium are due to unevenness of the light.

Winning Contest Answers; Borgeson Tops Field

(*Continued from page* 23)

output of the tube should be tested for an "open." An "open" in a filter condenser across the circuit would not take the load off the tube and would not stop the glow.

If the a.c. voltage is not normal, or if the plate fuses won't hold, disconnect the plate windings and check. If plate windings are o.k., discharge the condensers, checking them and the rest of the circuit for "shorts." If the rectifier output is short-circuited and is improperly fused, the low internal resistance of the tube will pass sufficient current to ruin it; and if the excess current endures long enough, any windings or parts of the circuit that are subjected to the overload are liable to burn out. Shorted plate windings will reduce the voltage across them.

An open circuit anywhere in the output of the rectifier that would take the whole load off the tube would cut off current flow across it and stop ionization, or glow. If there are parallel loads across the rectifier, as is always the case, an "open" that would stop the glow would be confined to that part of the circuit between the output and the first load.

An "open" in a voltage divider or bleeder circuit from which there are a number of parallel circuits tapped at different voltages, would not, of course, take the load off the tube.

14. What known electrical device could be used temporarily to keep the

show going if the power transformer of Fig. 1 should burn out?

By EVERETT RENFROE

A motor generator, if available, would make an ideal substitute in this case, for if it were designed for sound reproduction work it would probably be constructed with filament and high voltage output. Thus, only those circuits leading to the power supply need be opened in order to insert the m. g. circuit. But where would such a unit be available, especially during emergency runs?

The very best *complete device* that could be used would be an a.c. power pack having terminal voltages (filament and plate) that are encountered in standard practice, thus being immediately and directly adaptable. Any projectionist could construct such a pack, the cost being very reasonable. Power capacity should be adequate, however.

Becoming still more practical, let's note the meaning of the phrase "burned-out transformer." A burn-out, as commonly mentioned, does not render a transformer 100% useless unless there remains subsequently a short-circuit. Seldom is trouble experienced with filament secondaries, but mostly with high voltage or primary windings. If a primary is burned up, shorted, or burned open, the whole transformer is useless, thus substitutions would have to be made for both filament and plate power.

If the high voltage burns open, then of course the only problem involved is to get high-voltage d.c. to keep the show going. This could be done best by removing the rectifier tube and bringing the h.-v. d.c. from a tap on another amplifier unit working in co-operation with this unit to the proper polarized terminals. Another possibility would be to use B batteries. Also, in a pinch and by careful manipulation, the 220-volts feed lines in the projection room could be tapped and fed into the rectifier tubes as a half-wave rectifier, if the grounds on the amplifier can conveniently be disconnected and re-established through suitable condensers. Even if used as 110-volt full-wave, sound could be maintained at a lower volume, if the tubes are not rated over 250 volts on the plate.

If the filament circuit of the transformer is out, but the plate circuit is o.k., substitutions could be made by paralleling the tubes to amplifier units, if available, with no interesting detrimental effects encountered. Also, storage batteries could be used; and if the horn field rectifier is a separate unit, use resistors if necessary, or alter the circuits to series-parallel combinations to adapt that which is on hand to the requirements.

There are so many possible combinations that might be employed in such an emergency by one who "knows his stuff" that it would be impossible to exhaust the list herein. It's up to the individual to think about these trouble before they happen and plot his course of action.

In working with reduced power because of an emergency, it is well to remember that a decrease of one-half the power represents only 3 db., which loss is barely perceptible and allows ample latitude for decisive action. However, I still think that a power pack made up in advance with all necessary arrangements to serve any one of several amplifiers that may exist in a bank in any given location is the best "electrical device" to use, because it can match 100% the results of the original job, it can always be on hand, and it does not represent a big investment nor deteriorate appreciably over long periods of time.

15. In an amplifier arrangement like that of Fig. 1, if the amplifying tube plates showed excessively red, with sound distortion at high volume, where in the power supply circuits would you look for the trouble?

By LAWRENCE BORGESON

The excessive redness indicates excessive plate current caused by high plate voltage on all the tubes. The first step is to check the line voltage. Voltage regulators of power companies have been known to fail, causing excessive line voltage. (There are other causes of high line voltage.) The resultant high plate voltage on the tubes may cause distortion on high volume, occasioned by the tube operating on or above the knee of the grid voltage-plate current curve when the grid swing is relatively

large. On low volume the sound may be undistorted, as the grid swing may be sufficiently low to keep the tube operating on the linear portion of the aforementioned curve.

If line voltage is normal, the resistance R_8 in the lower left-hand corner of the schematic should be checked for open circuit (Fig. 1 on p. 20, March issue). If this resistance is open, the load on the power supply is reduced and the voltage rises. If only a single tube has an excessively red plate (V_1, V_2, V_3, or both V_4 and V_5) and there is distortion on high volume, one of the following troubles may exist:

1. Resistance R_{14}, R_{23}, or R_{11} shorted across, affecting V_1, V_2, or V_3, as the case may be. Plate voltage rises.

2. *Partial* breakdown of one of the following condensers: any of those marked C_2, or the one marked C_{11}, thus shorting some of the current around the associated resistor and making the respective bias sufficiently more positive than normal to occasion excessive plate current and distortion at high volume.

[NOTE: *Almost all the contestants muffed this question through assuming that high plate voltage will not overload a self-biased tube, thinking that the grid bias will rise with the plate voltage and so keep the current down. The idea is alright and tubes can actually be so biased; but it isn't done much in theatre amplifiers. In the vast majority of cases bias won't be high enough to work that way, and high voltage will overheat the tubes. Not a few readers of I. P. have seen the plates of self-biased tubes glow red or white-hot as a result of excessive line voltage.*—ED.]

16. What defects in a rectifier power supply can give rise to hum in the sound?

By J. T. KIRKHAM

This can be caused by loose power transformer laminations; leaky or shorted filter choke; leaky, open or shorted filter choke by-pass condenser; electrolytic filter condenser dried up; open circuit line voltage supply buffer condensers; open circuit center tapped resistance or bum control; or hum control or balancer out of adjustment.

In a three-wire system to loudspeaker field and voice coils, wrong connections at the speakers will cause hum. Also, a defective rectifier tube; poor ground on the filament circuit; conductive coupling; grounded choke; power transformer secondary winding shorted, causing unbalanced high-voltage winding, or one side open-circuited; a.c. power plug reversed; poor ground on power transformer.

Also, a shorted field coil, if same is being used as a choke in the filter circuit; gassy tubes; fixed or variable center tap resistors. Sometimes the choke in the rectifier plate circuit is defective and causes hum or noise. In a power rectifier with two half-wave rectifier tubes, if one tube becomes considerably weaker than the other, there is occasioned an unbalanced condition of the output power circuit, with resultant hum.

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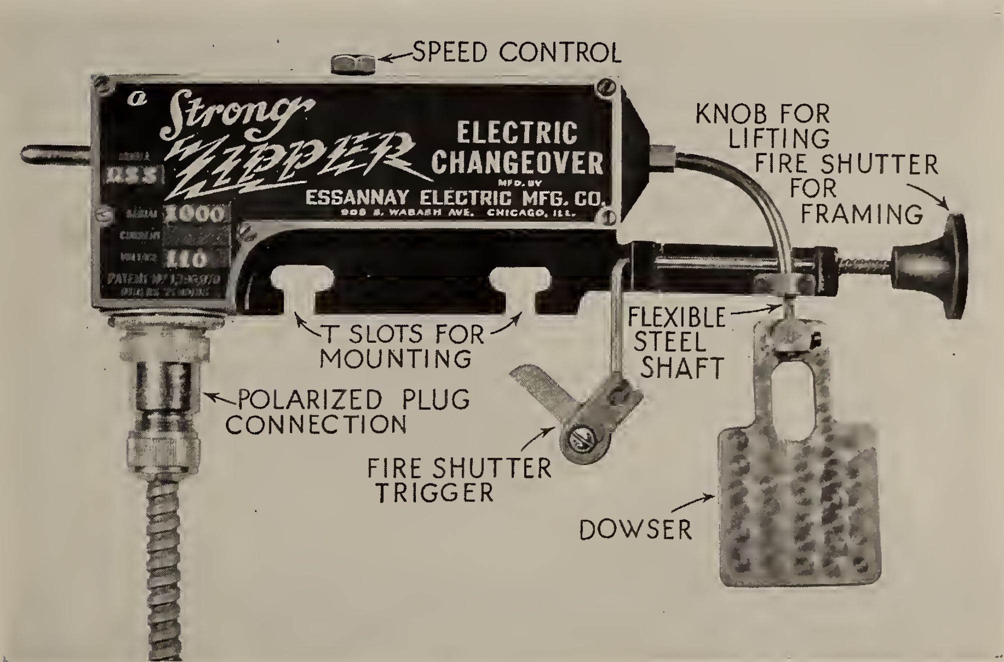

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Zipper Changeovers are available equipped with a sound switch so that sound and picture can be changed over simultaneously by merely stepping on the foot-switch. When so equipped, an auxiliary switch is provided for disconnecting the automatic changeover, so that the sound can be run off on one projector while the picture continues on the other.

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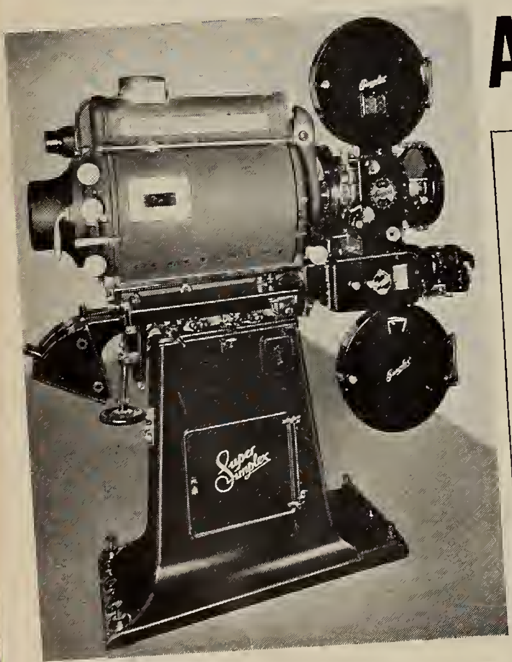

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2 Regardless of theatre size, one standard of equipment developing the highest quality of sound reproduction.

3 Manufactured by International Projector Corporation, builders of the leading projection equipment for over a quarter century.

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—John Eder, Carib Theatre, Kingston, Jamaica

SIMPLEX E-7 PROJECTORS GIVE MORE LIGHT

A new feature of the Simplex E-7 mechanism is the synchronized front and rear shutter—both operating on the same shaft. Each shutter acts upon one half of the beam to create a dissolving effect. Result: *12½% more light on the screen.*

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JUNE 1938

VOLUME 13 • NUMBER 6

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International PROJECTIONIST

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Edited by James J. Finn

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MONTHLY CHAT

COMMENT anent release print shortcomings appearing in I. P. recently have already been reprinted by technical papers in England, France, Germany and Russia. We're still awaiting returns from Eire. The rather tart observations by the distinguished Mr. Thad Barrows, of Boston, on this topic are preferred by our foreign contemporaries—probably because they still consider (mistakenly) Boston as the font of all knowledge in America. Hollywood is the name, suh.

• • •

Our mild and rather oblique reference to carbon dust in projection rooms in this space last month had hardly reached the hinterlands when there was deposited on our desk four booklets reflecting the research labors of more or less eminent scientists into this engrossing topic. The unanimous conclusion reached by these high-minded worthies is that, assuming the use of proper arc exhaust and room ventilation, the projectionist is but slightly affected, if at all, by arc fumes and carbon dust.

These conclusions are of paramount interest to this corner, no less tban to the men behind the projectors, and we shall attempt to evaluate them in the next issue.

TELEVISION continues to worry projectionists, judging from the contents of our mail bag within recent weeks. I. P. has already presented several authoritative articles on this baby art both from the technical and commercial viewpoints. Several more factual articles about the present status and future prospects of television are scheduled for early publication herein.

• • •

There's something radically wrong within a craft that is assumed to be ever on the alert to protect its members from industrial hazards when a request to a large Local Union for details of how one of its members was burned to death in a projection room fire—"the film exploded"—elicits the response that "no details are available." It's much too late, of course, to do anything to help the unfortunate victim of this happening, but a little data on the "how" of the incident might help mightily in protecting some other follows who still are around.

Incidentally, did you know that under the standard exhibition contract Mr. Exhibitor is held responsible for all damage done to film by fire? This is no weak argument to advance when the boss is balky about repairs or replacements.

• • •

Highly interesting data culled from the current report of the S.M.P.E. Projection Practice Committee: Only 16% of all theatres operating in tbe U. S. have satisfactory conditions for all the "basic considerations of proper motion picture presentation."

INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 6

JUNE 1938

Take-Up Troubles: How to Locate and Correct Them

By *A. C. SCHROEDER*
MEMBER, PROJECTIONIST LOCAL UNION 150, LOS ANGELES, CALIFORNIA

YEARS ago, when the film ran into a can or a gunnysack, no take-up problems ever bothered the projectionist. Things are different now: take-up failure induces considerable trouble. The lower reel must take up the film continuously, as fast as it runs down; and the film tension at this point must be at least fairly constant, to prevent other troubles.

As the reel "grows" it must turn slower and slower, making it impossible to use a positive drive mechanism. The simplest drive, then, is a friction device, which allows the necessary slip to occur.

Figure 1, which is exaggerated, shows a take-up shaft in a worn bearing. Sometimes the bearing wears as in Fig. 2, also exaggerated. Usually the condition will be somewhere between these two. Operation is not satisfactory under these conditions.

It is natural that most of the wear should occur at the right end of the bearing because it is carrying most of the weight, which is supported by a comparatively small surface near the end of the hole.

The arrow E indicates the pressure on the shaft due to the weight of the reel. The entire weight is carried by that portion of the bearing between A

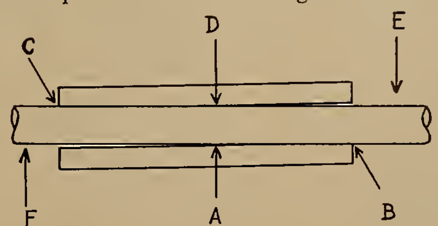


FIGURE 1

and B, which acts as a fulcrum, and produces a corresponding force in an *upward* direction on the bearing between C and D.

One of our houses recently had trouble at this point: the bearing was worn so badly that the shaft had a tendency to bind, thus making it necessary to tighten the friction device so that it would take up a full reel. This put too much tension on the film at the start of the reel, when the shaft did not bind, because there was comparatively little weight on the shaft at this time.

● End-Play a Vital Factor

Another cause of binding in the bearing is insufficient end-play in the shaft. Under this condition the projectionist may try the take-up: turning the reel by hand while the projector is idle and discovering that it "pulls" quite hard, he decides that it is alright; but it does not take up a full reel of film.

When turning the reel by hand he must not only overcome the drag of the friction device but also the drag of the shaft binding in the bearing, making it seem as though the friction was very tight and fully able to work properly.

The belt should now be removed and the spindle turned (without the reel),

to test for drag in the bearing. If the spindle is not perfectly free, the cause must be found and corrected. A sharp rap with a hammer on the end of the spindle will often "cure" the condition immediately. This must be done carefully to prevent injury to the parts. On the operating side be sure to bend over the shaft lock so that the blow comes directly on the shaft. It must be hit squarely, and a brass punch should be used so that the shaft end is not damaged. If carefully done, the direct hammer blow will not damage the shaft either; but this is not considered good practice.

On the opposite end the threads might be battered if the operation is done carelessly, but here the adjusting nut can be turned until its surface is flush with the shaft end, which will prevent injury to both the shaft and the nut.

What happens when the shaft is hit is that it causes something to slip. When the reel end of the shaft is driven, the collar on the inside of the magazine slips slightly on the shaft, thus allowing more end-play. This collar may already be out on the shaft as far as it can go, and thus cannot slip any farther, and the shaft cannot be freed in this manner. The other end can then be driven in, causing the driving disc to slip along the shaft, which allows the necessary end-motion in the shaft.

The setscrew in the driving disc or in the collar on the other end cannot be made tight enough to prevent slipping when the shaft is struck with a hammer. If the setscrew is sunk into a hole in the shaft, there obviously cannot be any movement of the part.

When the setscrews are very tight and the setscrew holding the bushing (the spindle bearing), in the magazine is not sufficiently tight, there might be a movement of the bushing in the magazine casting. Watch this carefully.

On trying the spindle for end-play it may be found that there is enough, but the spindle should be turned to be sure there are no tight spots. Sometimes there are high spots on the collar or other parts, and there seemingly is sufficient end-play, but when the spindle is turned so that the high spots are next to each other, the shaft will bind.

● Belt Tension Considerations

In some take-ups the upward pressure indicated by arrow F is increased by the belt tension. This upward force fulcrums about the C-D part of the bearing in Fig. 1, causing *additional* downward pressure on the part A-B.

A tight take-up belt is undesirable from several angles: it is an unnecessary strain on the belt, shortening its life and producing a tendency to break at the connection, the weakest part; it causes more wear on the shaft and the bearing, and it makes the shaft turn harder, necessitating more tension on the friction device. In addition to this we must remember the added wear on the upper pulley shaft, in the picture mechanism, and the additional strain on the gears.

Right here let us consider how to determine when the belt is too loose. If proper action is not secured after tightening the spring tension on the friction, some projectionists, immediately concluding that the belt is slipping, proceed to tighten it. No effort is made to determine if it is really slipping.

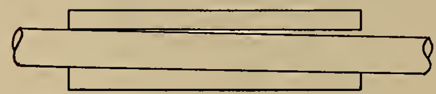


FIGURE 2

To be sure of the belt tension watch the lower take-up pulley and the take-up spindle toward the end of the reel. If the pulley is revolving rapidly, much faster than the take-up spindle, the belt is sufficiently tight; or it may even be too tight. If it is turning at about the same speed as the spindle, the belt is probably too loose.

Now for some exceptions. The belt may be too loose and be slipping *under existing conditions*, but it might be tight enough if the take-up were in proper shape. If the spindle binds in the bearing or a bent reel is being used, the friction must be tightened, which may cause the belt to slip. Apparently the belt is too loose, which it is under these conditions; but the conditions are wrong and should be remedied, and *then* one should determine the belt tension.

When the lower take-up pulley alternately runs fast and slow toward the end of the reel, it is due to a non-uniform belt or badly worn parts. Sprung, eccentric, or warped parts would also account for this. While the latter troubles are remote, it is well to keep them in mind when nothing else is found wrong.

A non-uniform belt, one that is less pliable in some parts than in others, may have a tendency to slip at times and to hold better at other times. When it holds good, the lower pulley runs fast causing the friction to slip; the next instant the belt slips and the friction locks the lower pulley, which slows down and runs at the same speed as the spindle.

A belt of varying diameter acts the same way. This may be due to poor construction of the belt or because the projectionist spliced two different belts together (a bad practice; the belt should always be in one piece). When the smaller diameter belt runs over one of the pulleys, the belt becomes looser because it sinks farther into the pulley. This may cause a loss of friction at the pulley, because the belt is then too small for the width of the groove, especially the upper one, which already has less driving force, being smaller and not so much of the belt contacting the groove.

The fact that the lower pulley runs at a uniform speed is not a positive indication that the belt is uniform throughout. A poor belt may be tightened enough so that it will not slip, but this also invites trouble: the belt will break prematurely.

● Pulley Size Important

When the friction device is too tight, the slip must necessarily occur between the belt and the pulleys. This is undesirable and should be corrected. The slip should occur between the friction discs, and the belt should be just tight enough to cause this action. In other words, the friction should be just tight enough to positively take up the largest reel, and the belt should be sufficiently tight to just cause the friction to slip.

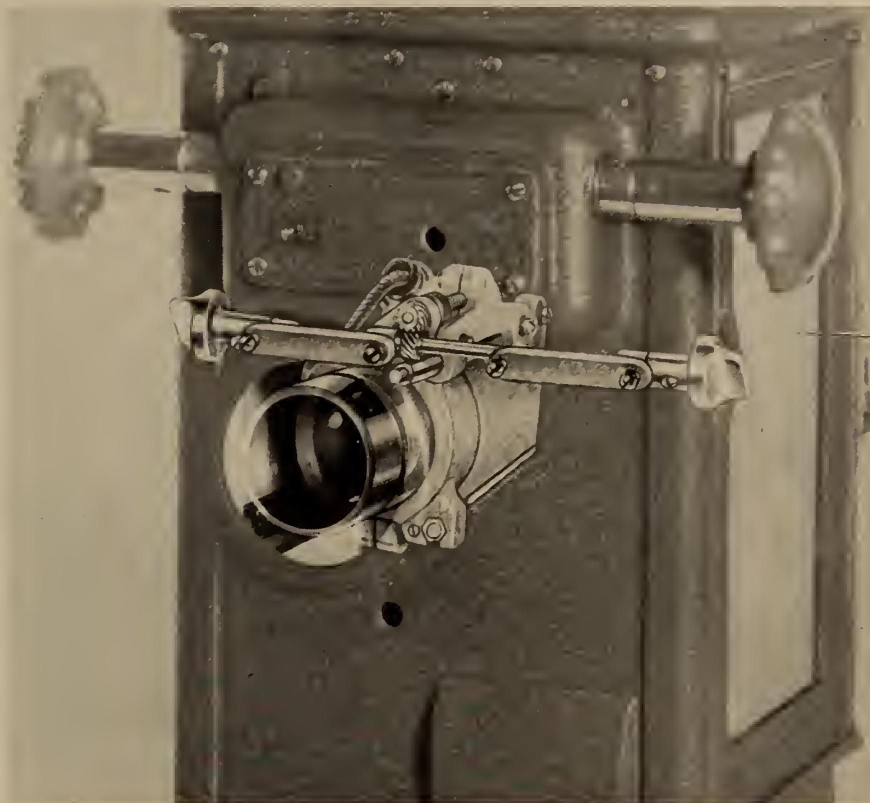
Pulley size has much to do with proper operation of the belt. A year ago we installed new equipment: the pulley in the second head was so small that the belt had to be very tight to prevent slipping, because the contacting surfaces between the pulley and the belt were too small. Result: the belts continually broke. These pulleys were then replaced by larger ones, requiring longer belts, of course. There was then enough friction between the pulley and the belt so that the latter could be run quite loose and still drive the take-up without slipping on the pulleys. Belt breakage stopped immediately.

Since then we have had special belts made. They are endless, having no splice, and are impregnated with a rubber compound. They have absolutely no stretch and must, therefore, be made the right length unless there is provision on the projector for adjusting the belt tension. These belts have not been in use long enough to prove their worth, but they seem to be much better than the old leather belts.

When a belt gets a trifle too loose for best operation, it is often possible to place a couple large washers between the magazine and the sound head, thus lowering the magazine a

(*Continued on page* 34)

SPLITTING HAIRS MADE EASY



● In using modern, high speed, color-corrected lenses, the Projectionist is called upon to make focusing adjustments of extreme precision — literally, to "split hairs."

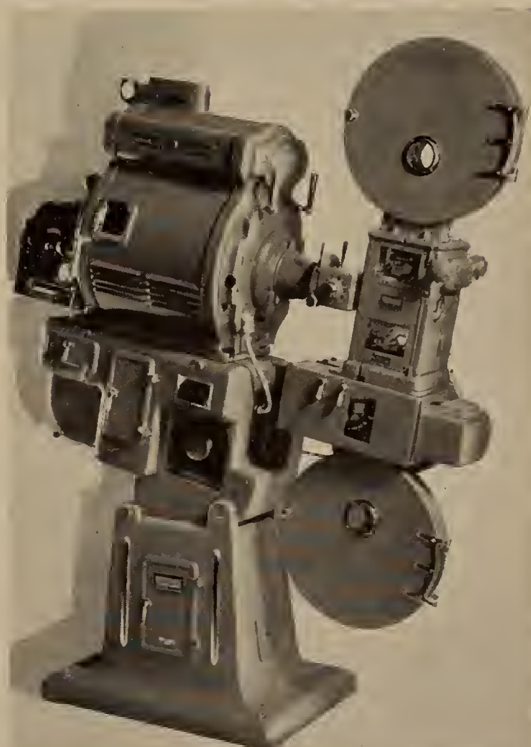
MOTIOGRAPH has simplified that job immensely by providing a ***Micrometer Focusing Adjustment*** (shown in the phantom view).

A quarter turn of the large, easily gripped focusing knob moves the lens less than eight thousandths of an inch . . . eliminating the possibility of running through the point of focus.

And this adjustment can be made from ***either*** side of the machine —without opening the mechanism doors. This important operating convenience is especially appreciated in running reels made up of cuts of film of varying thickness.

Provision has been made to take up wear at every point . . . lead screw end-play . . . guide shaft bearings . . . even the threaded portion of the lens mount, itself.

This positively insures smooth operation of the Micrometer Focusing Adjustment . . . and the maintenance of perfect optical alignment for the life of the projector.



● The MICROMETER FOCUSING ADJUSTMENT is only one of the operating convenience features of the MODEL "K" MOTIOGRAPH (shown at the right) which have won favor with Projectionists, everywhere.

● Your Motiograph distributor will welcome the opportunity to show you more. He will also be glad to give you full particulars on the convenient terms of the Deferred Payment Plan. See him today.

MOTIOGRAPH Inc., Chicago, U.S.A. IN SOUND PROJECTION *"The Standard of the World"*

Sound Equipment Troubles: Hum

By *AARON NADELL*

THE immense variety of undesirable conditions which can give rise to an identical hum in the reproduced sound makes this form of trouble one of the most difficult and obstinate, requiring strictly logical, methodical approach. Very few sound troubles are less responsible to attack by hunch and guess.

Hum can be divided into three broad classes: (a) of mechanical origin, such as sprocket hole noise; (b) of electrical origin and of line frequency and (c) of electrical origin but not of line frequency.

Line frequency hum is subject to further classification relative to the way in which they enter the system, inasmuch as line power is intentionally introduced into the system to provide operating force. But while the power is brought in, the hum or frequency of it is locked out by devices with which the projectionist is familiar, such as the rectifier filter or the hum-bucking coil in the loudspeaker. Line frequency hums, therefore, can be divided very usefully into those which enter through some defect in the locking-out arrangements just mentioned, and those which come in through an entirely different door, as by inductive or capacitative pick-up.

● **Mechanical Hum**

Mechanical hum is the easiest of all to deal with because there are only two places in the system where it can possibly originate, only two places that are subject to mechanical motion of any kind: the projector heads and the loudspeakers. Everything else is completely electrical (except in those antiquated equipments that may still use motor generators as sources of sound power; which will not be dealt with here because they are obsolete).

The possibilities of mechanically-created hum being thus limited, it is rather a simple matter to find out if a given hum is mechanical in origin. Note whether it disappears with change-over. If it does, proving that its source is at one of the projectors, the question of mechanical or electrical origin is easily settled (with no audience present) by switching off the projector motor. A mechanical hum will become progressively lower in frequency as the motor slows down, and it will disappear when the motor stops.

A mechanical hum at the loudspeaker is also somewhat easy to run down. A pair of headphones connected to the speaker input should hear any hum which is present in the speaker voice supply as an electrical frequency; if none is heard, the headphones will also reveal whether there is any abnormal ripple in the speaker field supply. Hum from the speakers which is not electrically introduced must be due to vibration of some part of the speaker, its baffle or its mounting. In practice such hums almost always reveal their nature without necessity for a headphone check, inasmuch as they disappear in silent passages and have a characteristic resonance.

The treatment to be applied to mechanical hum identified as such will be discussed hereafter: as a matter of logical procedure attention will be confined, for the present, to the problem of identifying an unknown hum and running it down to that general portion of the system in which it originates.

● **Line Frequency Hum**

Easily the most common form of hum is the electrical disturbance of line frequency. Possible causes of this trouble are almost innumerable. The projectionist can instantly think of a great many—light of a.c. origin reaching the photo-cell, mismatched rectifier tubes, and so on, indefinitely. And it is very possible that some early hunch will prove correct. On the other hand, this form of hum has been known to baffle competent service engineers for as long as several weeks in extreme cases. If an initial period of running down hunches, based perhaps on past experience with the equipment, fails to give results, the systematic approach becomes inevitable. Otherwise one might go on checking hunches almost forever.

A great advance is made if it is possible to find the location or region where the hum first appears. This can often be done with the help of the system switches and block schematic, assisted where necessary by headphones. If such methods can show that, for example, the voltage amplifier is the source of the disturbance, some hundreds of conceivable causes are reduced immediately to about a dozen.

On the other hand, if may not be possible to run down line frequency hum to any single unit. One reason is that even the best systems contain some dedegree of residual hum, which has slipped past the power supply filters. The trouble-shooter, applying his headphones, may find some difficulty in deciding at just which point the normal hum becomes abnormally loud.

One help in this connection is previous preparation. If the man with the headphones has taken the trouble to familiarize himself, in advance, with the volume of background hum that is normally present at every test point in his system, he will recognize an abnormal increase in time of trouble. In default of such preparation, a useful trick is to introduce sound at very low level—low enough not to mask the hum—and test through the system listening to sound and hum simultaneously. At some point along the line the apparent amplification of the hum is much greater than the amplification of sound, and that, obviously, is the point where abnormal hum is getting in.

There are cases, however, when no test can run down line frequency hum to a given unit or component, because the trouble actually is not confined to one source within the system. This is especially true of hum that did not appear suddenly, but grew stronger over a period of time until at last they became strong enough to need attention. In such cases there may not be any single cause, but a number of weak hums adding up to an annoying final result; and the only useful remedy is a general overhaul and tuning up of the system—cleaning, tightening connections and transformer laminations, rebonding grounds, and so on.

Again, there are cases where no single cause for line frequency hum can be found because the trouble is external in origin, and entering the system, via induction, ground loops, or both, at a number of different points. The best remedy there is to find the external cause, which perhaps may be misperformance of the marquee flasher contacts, or of an air-conditioning motor.

But the trouble may be outside the

Progress Note

WE SEEM to have started something by publication in I. P. of data relative to unsuitable prints. Yes, indeed. So much so that I am glad to report that the conditions we mentioned are steadily getting worse. Sepia print of Kidnapped (20th C.-Fox) is so dark in many places that, if it didn't have a sound track, it would result in a blank screen. Light source: 125-ampere h.i.

Just thought that the West Coast technical "experts" would like to know how their "art forms" look in theatres.

THAD BARROWS
Metropolitan Theatre, Boston, Mass.

theatre entirely. The writer knows personally of cases where the cause proved to be an ice-cream machine in a store down the street, a refrigerator in a private apartment, and a doctor's electrotherapy machine. He knows of another case where the trouble was traced to the power company's supply line, but power company and sound engineers working together were never able to find it, and the only remedy was to block it out of the system. It was found that the trouble got in through an unknown and improper ground in the theatre's wiring, resulting in a high-resistance ground loop. The faulty ground was never located, but rearrangement of all system grounds effected a cure. This was an extreme case.

When systematic approach fails to isolate a line frequency hum to some one part of the system (which can then be investigated internally) the next step —if the trouble came on gradually— should be a general overhauling and tightening up; but if this does not help, or if the trouble appeared suddenly, the chances are that the cause is external. An excellent procedure in such cases is to switch, temporarily, to another power circuit, wherever that is possible. A cure achieved in this way indicates that all machinery connected to the power line previously used needs investigation.

Intermittent appearance of the trouble is very helpful in cases of hum of external origin, since it can thus be synchronized with those times when the suspected external machinery is in use, and the faulty machine is rather easily found. What to do about it is another matter, and will be taken up later.

It should be added here that, especially with the well-shielded, efficiently grounded modern systems, hums of external origin constitute a very small portion of all line frequency hums, and that possibility should not normally be considered until after every possible effort has been made to find the trouble within the system itself, and have failed.

● Other Electrical Hum

Hum that is electrical in nature but not of line frequency constitutes a third and distinct class, which can be identified as such by the pitch of the disturbance and by the fact that it has been shown to be non-mechanical in nature.

The trouble may be internal or external in nature, but the possibilities are often limited by the nature of the sound. The pitch of commutator pick-up, for example, is easily recognized. The most common source of such pick-up is the arc feed motor, which is the first place to look when commutator hum is heard. Other external commutator hum presents much the same conditions and difficulties as external line frequency hum, and is treated in the same way.

Figure 1 represents a basic principle in modern amplifier wiring intended to avoid another type of hum, commonly and aptly called motorboating. But it may have almost any pitch—the tone is no criterion. However, if a non-line frequency hum has been traced to a given amplifier, motorboating, per Fig. 1, is one of the possibilities to be investigated.

In this connection the vital parts of the diagram are the "decoupling" units, C-1 and R-2, C-2 and R-4. Consider the amplified speech current which is generated between the plate and cathode of the right-hand tube. If that plate and cathode are taken to be the poles of a generator of speech a.c., the load across them consists of R-3 and C-2 in series. There is a parallel load right through the output to the grid of the next tube, or to the loudspeakers, as the case may be. But, there is another parallel path, down through R-4, through the B source to ground, and from ground back to cathode.

If any appreciably large part of the speech current is allowed to traverse this last path, motorboating will result, for the reason that the B source is common to both tubes. Consequently a part of any alternating current that flows in the B source must get back to the left-hand tube, or input, and such feedback will cause the entire circuit to oscillate. The frequency of the oscillation will depend on the values of the condensers and resistors involved; it may be almost any frequency, including those that do not fall within the audible range.

C-2 and R-4, the decoupling units in the right-hand tube circuit, exist to prevent such feedback. C-2 provides an easy short-circuit around the B source, while R-4, in series with the B source, increases its effective resistance and further encourages the current to take the other path, through C-2. If R-4 short-circuits, the speech a.c. in the B source will increase; the same will happen if C-2 open-circuits; in either case the result will probably be a hum at some audible frequency.

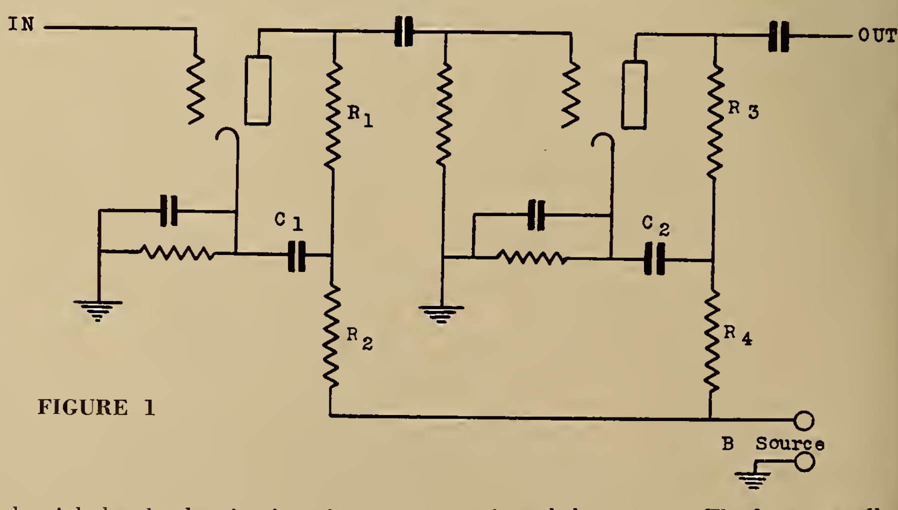


FIGURE 1

If the reader's own amplifying equipment is of modern design he will find in its schematic decoupling arrangements in some way similar to, not necessarily identical with, those here shown.

● Detailed Treatment

Assuming that a hum has been identified, as described, with a mechanical condition located in or about the sound head, the balance of the job usually is simple. Interrupting the exciting light for a moment and noting the effect on the hum further limits the remaining possibilities. Hum of mechanical nature associated with the loudspeakers, their baffles or mountings, usually is found without trouble, since the vibrating part can be both heard and felt.

A more serious complication is introduced by hums of acoustic origin, in which the vibrating part is not physically associated with the loudspeakers but resonates in response to the sound waves. The offending object may be located anywhere in the auditorium or about the stage; if it can be approached, it is easily found by ear, but if it is high up, as in the case of a lighting fixture or ceiling ornament, the problem becomes troublesome without being intricate.

Line frequency hums that can be localized to an individual component are the easiest to deal with. There are only two broad classes of possibilities: either the hum is getting along with the power, through some defect in the rectifier or filter arrangements, or it has found an unintended entrance. The latter usually turns out to be a high-resistance connection.

Contrary to what might be expected, most induced hum is picked up not magnetically but statically. The first cir-

cuits to be investigated, therefore, are the high impedance, that is, the grid, circuits. A dirty grid prong or a loose grid cap picks up line frequency from the power input in spite of the best of filtering in the power supply proper. A general cleaning and tightening up often effects a cure without necessity for detailed investigation. When this remedy fails, the rectifier and filter arrangements can be investigated in detail.

One possibility here which is sometimes overlooked, is a loosening of the laminations of the power transformer, or of a choke coil. Vibration of those laminations under the influence of the alternating field induces a reinforced line frequency which the filter may not be able to take out completely.

A peculiar difficulty is presented by external pickup traced to defective functioning of some outside motor or machine connected to the same power source. If the faulty machine is part of the theatre's equipment its repair usually can be arranged, but sometimes involves considerable expense, making investigation of other methods advisable. If the offending device is outside the theatre altogether, the owner may be unwilling to do anything about it. If the fault be in the power line, the power company will cooperate; such a fault means waste, and they are anxious to find it and stop it in their own interest.

When for any reason an external cause of hum cannot be found, removed, repaired or filtered, the only alternative is to block the hum out of the system, or to ground it out. The fact that it comes in through the power line, which must remain connected, does not mean that the trouble can't be blocked out; it does no harm in the power line but only in the speech circuits, and enters them in most cases through the B supply, probably the photocell supply. One possible remedy is inclusion in the d.c. line in question of an audio filter tuned to the frequency of the commutator ripple or other disturbance.

Grounding is usually preferable, and effective if properly done. The important point to remember is that even a hum pickup must have two wires through which to flow, and a potential difference to drive it. If all grounds are brought to a single point, hum cannot get in through the grounds—it will have only one wire to flow through. The usual return for such pickups is through a second ground connection.

All sound systems have more than one ground — through the projectors, through the power line, and usually a separate ground of their own. These grounds cannot be brought physically to a single point, but the effect can be achieved electrically by really thorough bonding. Connections must be electrically tight, of practically zero resistance, and the connecting wire, strip or other bond should be large enough to insure that no appreciable voltage difference can exist between the different earth connections. The bonding should take in *all* grounds that are related to the sound system directly or indirectly.

The work and trouble of improving grounds in this way can sometimes be reduced by eliminating one or more of the ground points. Some systems are found to be over-elaborately grounded; it will often prove possible to eliminate an earth connection without harm, and perhaps to eliminate a hum by so doing, when the normal procedure would be to run a heavy bonding wire to it.

M. G. M. Film Lubrication Policy

Reflecting the rapidly increasing interest of projectionists in, and emphatically expressed opposition to, present methods of waxing release prints is the appended statement by a noted authority on laboratory procedure. This statement was originally made in a letter addressed to Paul R. Cramer, Hollywood projectionist.

By *JOHN M. NICKOLAUS*

SUPERINTENDENT OF PHOTOGRAPHY, METRO-GOLDWYN-MAYER PICTURES

REPLYING to your suggestion that we give you some explanation of what our present so-called "waxing" condition is, I though it would be well to go back to the beginning and bring the subject up to date, as the result of the research work that we have done, and, for that matter, still are doing . . .

In the pre-sound days most film was waxed on the Eastman waxing machine, which consisted of running film over a knife edge wheel which was revolving in direction opposite to the film, carrying with it some heated paraffine wax. This, when cool, left a line across the perforation of dry, hard paraffine.

Apparently this was satisfactory until the advent of sound, when it was discovered that particles of the dry wax got on the sound track, creating objectionable noises. That difficulty suggested a change which brought us up to the liquid wax, which was applied in much the same method as the heated wax but with a wider application wheel.

This seemed for a time to solve the problem, but finally became annoying because we still got a pick-up of wax on the old-fashioned sound pads. Then, after much research, we found that some lubricant other than wax was necessary, which brought us up to the present method, which we feel has given and is giving the best results obtainable so far, and has definitely proven that if the first- and second-run projection machines are in reasonably good adjustment, no trouble results.

● Present M. G. M. Practice

Our present solution is not a wax solution but really an oil lubricant, as we believe the most beneficial agent in the solution is the pyrol, the wax being added as a carrier for this oil. The formula of the solution is as follows:

50 Oz.	Trichlorethylene
50 Oz.	Benzol C.P.
7 Oz.	Parowax (Standard Oil of Indiana)
2½ Oz.	Pyrol, Grade B.

We feel that one reason for the success of this solution lies very largely in the method of applying it. For applying this solution we are using the Eastman waxing machine, which we have modified to some extent, as follows:

The machine has the Eastman improved fountain tank and applicator roller drive in this way: in place of the nearly sharp discs which the Eastman Co. used, we are using hardened stainless steel three-inch discs 7/64" wide, which apply an extremely thin amount of this solution on each side of the film from the outside edge in to the inside edge of the sprocket holes.

As these discs revolve very slowly in the direction opposite to the film, there is a felt wiper that wipes the superfluous solution off the disc before it strikes the film, which allows an extremely small amount of the solution to be applied to the film.

● A Lubricant, Not a Wax

We think it is perfectly proper to refer to this solution as a lubricant, and never refer to it as a wax solution, because in reality there is no wax. That very small proportion of wax that is added to this quantity of solution is nothing more or less than a filler for the oil, which we found during our experimenting to be too thin for this purpose. Certainly there is nothing left on the film that could possibly cause a pick-up, and since this oil is such a remarkable lubricant, it is very evident that nothing but a rough or unevenly worn shoe could possibly pick up the emulsion. If the shoes are smooth, as they should be, this solution has a tendency to polish, but certainly does not encourage a pick-up.

We are always anxious to receive suggestions from projectionists running our film, as their co-operation is very necessary to future developments, and I would like to take this means of encouraging their co-operation.

FOR convenience in conducting the studies on the many projects engaging the attention of the Projection Practice Committee of the S.M.P.E. several Sub-Committees have been formed which have been working very vigorously on their respective problems throughout the year. However, in view of the pressing need for reliable information on theatre structures, that part of the work was pressed forward with all speed so as to be able to report on it at this time.

Another important job that the Committee is doing resulted from a request by the National Fire Protection Assoc. to study the "Regulations for Nitrocellulose Motion Picture Film," with the view of presenting to the NFPA any recommendations for changes that the Committee might deem advisable. Accordingly, the Sub-Committee on Fire Hazards has completely revised all the NFPA regulations referring to projection rooms, and has the material in shape for presentation to the NFPA Committee on Hazardous Chemicals and Explosives. The latter Committee will probably take several months to consider the recommendations, after which time it is expected that the proposed regulations may be presented to the Society, probably as a joint report of the S.M.P.E. Projection Practice Committee and the NFPA Committee on Hazardous Chemicals and Explosives, and eventually published in the *Journal.*

Auditorium Design and It's Relation to Motion Picture Projection

A REPORT OF THE PROJECTION PRACTICE COMMITTEE OF THE S. M. P. E.†

For some months the Projection Practice Committee of the S.M.P.E. has been conducting a survey of motion picture theatres for the purpose of determining the existing conditions under which motion pictures are presented. The accompanying report summarizes the data obtained from the survey and presents them in the form of charts showing the ratios of viewing distance to screen width, seating length to seating width, and seating width to screen width. Other charts show the distance from the floor to the bottom of the screen, the angle of projection, screen width, and arc current.

The survey covers approximately 600 theatres, and is shown to be fairly representative of the entire industry by reason of the fact that index figures calculated from the survey for only 400 theatres did not change when the number of theatres increased to 600. The data presented are to form the basis of an analysis leading to the determination of criteria for proper motion picture theatre design.

MOTION picture theatre structures should be designed according to standards that will insure satisfactory reception by the audience of the screen performance. The need for such standards has been emphasized by the survey made by this Committee of approximately 600 theatres. Charts similar to that shown in Fig. 1 were distributed by the Committee among a number of large companies of the industry whose engineers assisted in obtaining the dimensions requested on the chart. Accompanying the charts were letters describing the purpose of the survey.

Instead of mailing the charts directly to the managers of theatres, it was felt that the results would be more uniformly determined if the measurements were made and the charts filled out by men experienced in such work. Accordingly, the field men and management of RCA Mfg. Co., International Projector Corp., Electrical Research Products, Inc., National Carbon Co., Forest Mfg. Corp., Bausch & Lomb Optical Co., and National Theatre Supply Co. are all to be thanked for their co-operation. In addition, a number of charts were distributed to the delegates to the Convention of the MPTOA at Miami last March.

Although the survey includes only about 4 per cent of the total number of theatres in operation in the United States, care was taken so that these 600 theatres would represent a fair cross-section of all the theatres of the country. Theatres in every State and theatres of capacities varying from 200 to 4,000 seats are included in the survey. Averages computed from the survey at a point when 400 theatres were covered showed the same index values as when the number of theatres surveyed reached 600, indicating that the facts obtained are fairly representative of general theatre conditions.

● 84% of Houses Unsuitable

The information obtained from the survey reveals the fact that the basic theatre forms, relative screen sizes, and viewing conditions vary to a very wide extent. Variations in design, as shown in the graphs, spread over an extent of at least three times what might be regarded as tolerable. *Only* 16 per *cent of all the theatres surveyed proved to have satisfactory conditions for all the basic considerations of proper motion picture presentation.* Considering only the theatres erected after 1930, the percentage was 27.

A set of standard requirements for theatre construction could easily have limited these variations and thereby have benefited motion picture presentation greatly. As it is, however, there appears to have been considerable neglect, disregard, or ignorance of motion picture viewing principles in the design of motion picture theatres. This is evidenced by the fact that the smooth broken curves, drawn through the jagged graphs for the purpose of roughly representing average tendencies, are amazingly similar in general shape to the well known probability curve.

The inference follows, therefore, that the fulfillment of satisfactory viewing conditions in theatres, up to the present, has been primarily a matter of chance and not of intention. Perhaps this disregard of proper motion picture design principles may be attributed to the fact that motion picture theatre design has evolved from the stage-theatre form, which is unfortunate since the basic form required for the stage theatre is quite different from that required for the motion picture theatre.

Since the motion picture has become the sole, or, at least, the most important means of entertainment in almost all theatres where motion pictures are exhibited, it is important that recommended practices for motion picture theatre design be formulated. Such recommended practices could be followed as guides not only in designing new theatres but in remodeling and re-equipping existing theatres. They would indicate the ideal conditions desirable in new structures and the variations from the ideal that would be tolerable, if necessary, in correcting undesirable conditions in existing structures. To be of practical use these

† J. Soc. Mot. Pict. Eng., XXX (June, 1938), No. 6.

standards should take cognizance of such physical conditions as:

(*a*) regular and emergency audience "traffic";
(*b*) practical structural possibilities;
(*c*) shapes of ground pots; and
(*d*) limitations of motion picture film and equipment.

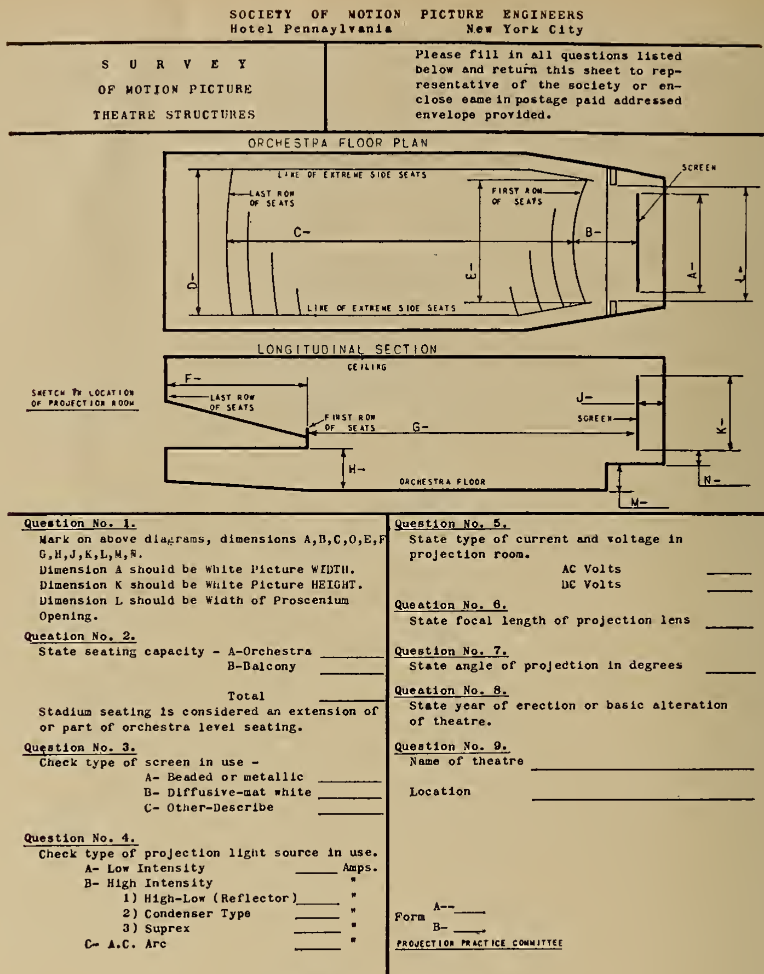
Special attention should be given to all such matters in order that the proposed practices may be applied in a sufficient number of instances to assure raising the general quality of motion picture presentation. The survey made by the Committee clearly indicates that the practical limitations are not the only causes of the existing undesirable conditions, but that there has been almost a complete lack of scientific planning of the motion picture structure. Proper relative importance can, of course, be given to practical considerations; but, at the same time, all possible importance must be assigned to design principles based upon scientific planning.

● The Ideal Film Theatre

The ideal motion picture theatre would be one that contained the maximum number of desirable seating positions per cubic foot of structure. In many instances where the shape of the ground plot, or the laws governing exit facilities, *etc.*, have been such as would assist in building satisfactory theatres, there have been no design principles or recommended practices available to guide the designers. In other instances where the conditions, to begin with, were not so fortunate, the poor proportions of the ground plots or the restrictions of building laws led to the erection of motion picture theatres most unfortunate in design.

Therefore, any recommendations of this Committee should include recommendations indicating the best possible use of poorly proportioned as well as more correctly proportioned plots. This is necessary because street plans and excessive land costs produce many variations in ground plot shapes.

Laws governing theatre construction in many instances require that aisles, passageways, and exit doors be so located as to cause a loss of valuable seating area. These laws have been made with little regard for their effect upon the proper functioning of the theatre from the standpoint of motion picture presentation. Proposed practices for theatre construction must therefore indicate the placement of traffic areas where they will diminish the effective seating area least. They should also indicate to the governing authorities wherein their existing safety laws may interfere with the better design of theatres without prejudicing to any extent the safety considerations upon which the laws originally may have been based.


SOCIETY OF MOTION PICTURE ENGINEERS
Hotel Pennsylvania New York City

S U R V E Y
OF MOTION PICTURE
THEATRE STRUCTURES

Please fill in all questions listed below and return this sheet to representative of the society or enclose same in postage paid addressed envelope provided.

Question No. 1.
Mark on above diagrams, dimensions A,B,C,O,E,F G,H,J,K,L,M,N.
Dimension A should be White Picture WIDTH.
Dimension K should be White Picture HEIGHT.
Dimension L should be Width of Proscenium Opening.

Question No. 2.
State seating capacity - A-Orchestra ______
B-Balcony ______
Total ______
Stadium seating is considered an extension of or part of orchestra level seating.

Question No. 3.
Check type of screen in use -
A- Beaded or metallic ______
B- Diffusive-mat white ______
C- Other-Describe ______

Question No. 4.
Check type of projection light source in use.
A- Low Intensity ______ Amps.
B- High Intensity "
1) High-Low (Reflector) ______ "
2) Condenser Type ______ "
3) Suprex ______ "
C- A.C. Arc ______ "

Question No. 5.
State type of current and voltage in projection room.
AC Volts ______
DC Volts ______

Question No. 6.
State focal length of projection lens ______

Question No. 7.
State angle of projection in degrees ______

Question No. 8.
State year of erection or basic alteration of theatre.

Question No. 9.
Name of theatre ______
Location ______

Form A-- ______
B- ______
PROJECTION PRACTICE COMMITTEE

FIGURE 1. *Survey Chart*

With the modern fireproof and fumeproof construction employed for projection rooms, with the elimination of stage scenery and excess draperies, and with the generally fireproof nature of the entire theatre building, a new approach may be made to the question of emergency exit requirements. This Committee now includes a theatre architect and a State official on theatre construction inspection. In addition, other architects and governing authorities are being invited to supply such information to the Committee as will make it possible to submit the final findings as a guide to be used by all the states and municipalities in writing laws relating to motion picture theatres.

It is the opinion of the Committee that all motion picture theatre construction should be under the guidance of competent theatre architects.

In addition to improving the general quality of motion picture theatre design, structural standards will assist a great deal in clarifying many of the motion picture equipment problems. For example, light-producing sources, motion picture screen characteristics, and sound systems might be classified according to their ability to fulfill the requirements of definite types of theatre structure.

The basic design of the motion picture theatre depends more than any-

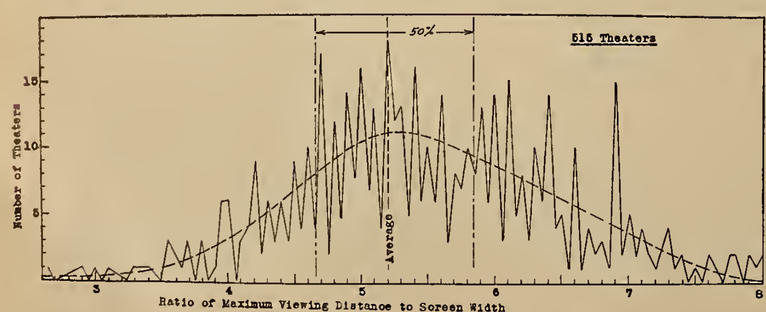


FIGURE 2

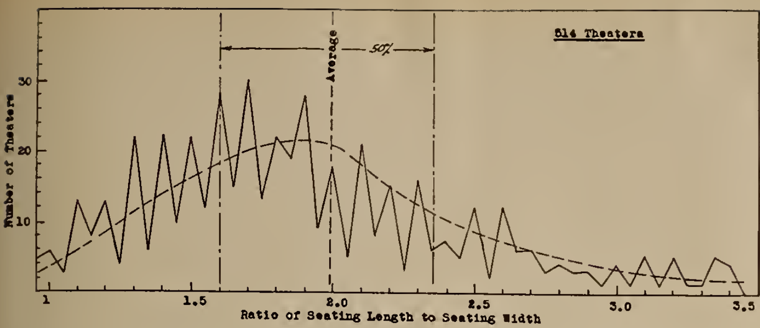


FIGURE 3
Seating area characteristics

thing else upon the necessity of satisfactorily viewing the picture. The factors involved are:

(1) Picture detail:
 (*a*) Screen size in relation to viewing distance.
 (*b*) Screen brightness.
(2) Obstruction of view.
(3) Distortion of picture:
 (*a*) In projection.
 (*b*) In viewing.

Figures 2-9 and Table I have been computed from the data provided by the returned survey charts. Figs. 2 and 7 will be especially helpful in studying the picture detail problem. Fig. 5 is intended for use in determining the area of the screen obstructed by the heads of spectators. Figs. 3 and 4 indicate the conditions controlling picture-image distortion due to viewing angles. Fig. 6 shows the projection angle, another factor affecting picture-image distortion.

● Trend Toward Small Houses

The survey indicates that seating capacities have steadily become smaller. Whereas 26 per cent of the theatres surveyed, erected before 1930, have capacities of 1,500 seats or over, only 10 per cent of the theatres erected after 1930 have capacities so great. Theatres of 2,000-seat capacity and over, erected after 1930, amount to only 5 per cent of the total.

Future recommendations should show the disadvantages encountered when capacities of over 1,500 seats are contemplated. A point to be noted in the survey is that the characteristics of the theatres having capacities greater than 2,000 seats do not fall within the 50 per cent group, indicating that an important percentage of the seats in these large theatres are more or less subject to undesirable viewing conditions, and that best results in establishing standards of design will be attained if the seating capacities are assumed to be, say, 1,500 or less. This maximum applies to the usual rectangular ground plan. Somewhat greater capacities may be possible in a trapezium-shaped ground plan.

Although the screen-image size is related to the maximum viewing distance, screen-image sizes in the theatres covered indicate a tendency toward sizes too small for the given viewing distances. This may be due to a general desire to avoid sufficient mag-

FIGURE 4
Relation of seating width to screen width

nification to reveal film graininess and thereby assist in rendering seats closest to the screen undesirable. Fig. 8 shows that the average screen-image is 18.5 feet wide, 50 per cent of the theatres surveyed having screen-images ranging from 16 to 21 feet wide.

Using the average screen width of 18.5 feet (Fig. 8) and assuming this width represents maximum desirable magnification of the 35 mm. film, approximately 800 seats can be arranged in a single tier. Should the maximum permissible magnification be assumed capable of producing an acceptable 25-foot screen image, a capacity of 1,100 seats would be accomplished in a single tier. These capacities are arrived at by assuming, temporarily, the averages indicated in Figs. 3 and 4. If a second or upper tier of seats be employed in both the 800- and 1,100-seat instances, these capacities would be increased respectively to approximately 1,200 and 1.700 seats. *These figures indicate the reason for assuming that* 1,500 *seats may be the advisable maximum capacity.*

While the data shown in the graphs do not determine, without further study, ideal theatre proportions and dimensions, they do, however, reveal conditions that may be regarded as at least tolerable. For example, the conditions in theatres the proportions and dimensions of which fall within the 50 per cent group marked on the charts may, for immediate practical purposes, be regarded as tolerable. Fig. 9 depicts these characteristics graphically. The figures shown should not be interpreted as representing any attempt on the part of the Committee, as yet, to fix maximum or minimum conditions: further analysis is required.

Considered from the standpoint of visual aspects only, the ground plan of a motion picture theatre is controlled, first, by the ability of the audience to see the details of the picture. This ability is determined by:

(*a*) The illumination of the screen;

(*b*) The brightness contrast of the projected image;

(*c*) How much image detail is to be discernable to the spectator (the art of cinematography is here the guiding factor);

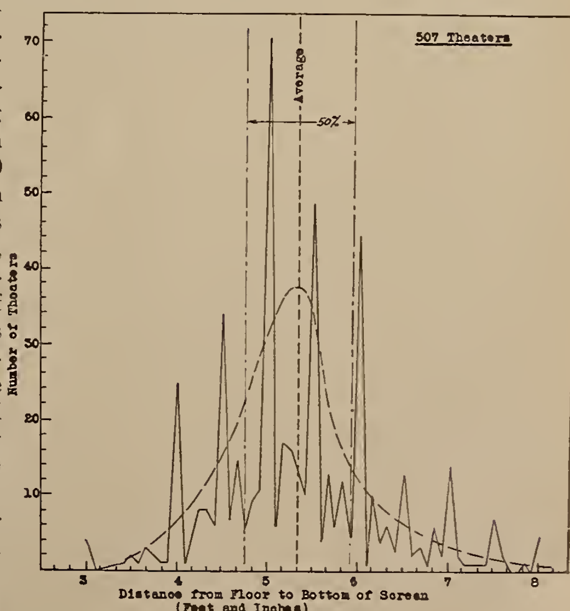


FIGURE 5
Location of screen above floor of auditorium

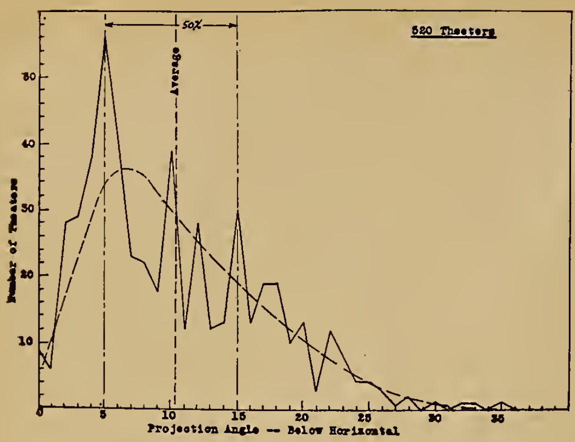


FIGURE 6

Projection angle

(*d*) The width of the film, which controls the maximum screen-image size.

Second, the ground plan is controlled by the area within which the viewing angles afford an acceptably undistorted appearance of the two-dimensional screen-image.[1] Still another consideration in determining the ground plan is that of choosing between a single tier of seats and a multilevel seating plan. The desire to

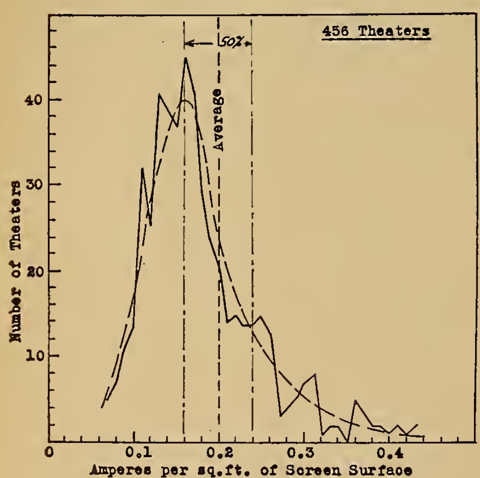


FIGURE 7

Projector arc current

obtain a maximum number of seats on valuable ground area has usually been the important reason for adopting upper-level seating schemes. Yet the most plausible reason for multilevel seating is that excessive viewing distances can be avoided and minimum screen-image sizes can be used. The multilevel seating scheme would tend toward a more squarely-proportioned and smaller ground plan; whereas the single-level seating plan tends toward the elongated rectangular plan, and, naturally, larger ground area.

The ideal motion picture theatre form, considered from a purely technical and artistic standpoint, may develop into a form that may not in some instances fulfill all the rigid requirements set forth for the commercial motion picture theatre; yet it is the obligation of the Society to indicate what would be the most desirable form of theatre, and all those who are concerned with the design of theatres may adhere as closely to these recommendations as may be practically possible, in any case being sure to stay within the limits set forth as tolerable.

● Determining Characteristics

The following principles determine the characteristics of ideal motion picture presentation:

(1) Minimum seating capacity, permitting minimum screen-image sizes.
(2) Control of screen-image size, to avoid over-magnifying film graininess.
(3) Minimum viewing distances, to enable greater cinematographic use of the screen-image.
(4) Maximum seating capacity possible while still adhering to the requirements of (2) and (3) above.
(5) Maximum number of seats within an area from which the screen-image will not appear objectionably distorted.
(6) Floors or steps properly graded, to afford unobstructed view of the screen-image from every seat.
(7) Maximum screen brightness, using a minimum of electric power.

It is the intention of the Committee to give further detailed study to the problems of picture detail, screen brightness, cinematography, magnification ratio, image distortion, and obstruction of the screen-image. By considering the factors revealed by the survey and other studies it will be possible to formulate definite recommendations for standards for motion picture theatre design.

● Projector, Screen Light

For a long time the Committee, through its sub-committees, has been working on the problem of obtaining meters that could be used in theatres for measuring the light from the projector incident upon and reflected from the screen. Such meters should be simple to operate and relatively low in cost, in order to be within the means of all theatres. Meters have been available in the past by means of which such measurements may be made, but in all cases the meters were very high-priced and required for their operation men specifically trained in the art of handling meters.

Some progress has been made, however, in that a meter is now available by means of which the incident light may be measured, but no report can be given at this time as further studies are being conducted with the meter with regard to its use in connection with screens of various types and under various circumstances.

Very little progress can be reported, however, with regard to measuring the

P. P. Committee Personnel

H. Rubin, *Chairman*

T. C. Barrows	C. F. Horstman
F. E. Cahill	D. E. Hyndman
J. R. Cameron	J. J. Kohler
A. A. Cook	P. A. McGuire
C. C. Dash	E. R. Morin
J. K. Elderkin	M. D. O'Brien
J. J. Finn	G. F. Rackett
R. R. French	F. H. Richardson
E. R. Geib	B. Schlanger
A. N. Goldsmith	C. Tuttle
A. Goodman	J. S. Ward
S. Harris	V. A. Welman
H. Griffin	A. T. Williams

J. J. Hopkins

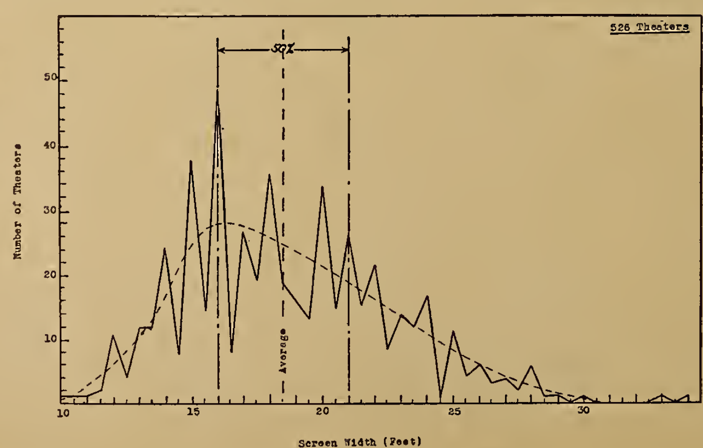


FIGURE 8

Chart of screen widths

[1] TUTTLE, C.: "Distortion in the Projection and Viewing of Motion Pictures," J. Soc. Mot. Pict. Eng., XXI (Sept., 1933), No. 3, p. 198.

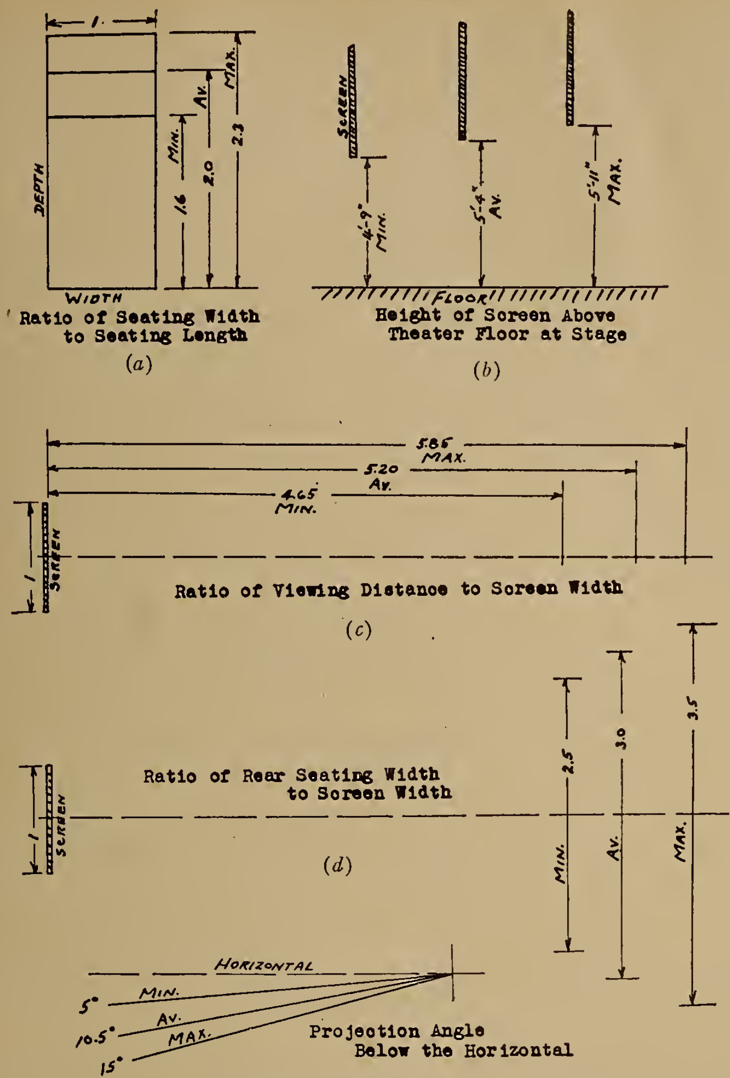


FIGURE 9

Characteristics of theatres falling within the 50% group

reflected light, so that for the present no means are available for determining the reflection coefficient of the screen other than by using specially measured and graded samples of paper such as accompanied the report of this Committee in the June, 1933, issue of the S.M.P.E. *Journal.*

The Committee plans to continue its work on screen illumination during the coming months, and hopes to render a more definite report at a later time.

DISCUSSION:

Mr. Jones: This is one of our most active committees, and, under the direction of Mr. Rubin, has held monthly meetings for quite a number of years. The Committee is to be congratulated and thanked by the Society for this most excellent work. This is one of the first really adequate surveys of theatre conditions, and the Society should consider its value as very great indeed.

Mr. Goldsmith: The Committee has not proposed herein any standards. This is no attempt to crystallize theatre practice at this stage. The report is merely based upon the safe assumption that the median characteristics of the 50 per cent group centering around the average, represent tolerable practice at present, because many millions of persons enjoy and pay for the performances that result within those conditions, and the audience probably enjoys them most around the average conditions. On that basis the report, without being stereotyped or frozen, does give a great deal of help to the architect, to the exhibitor, and to the designers of equipment. It is believed to be the most valuable theatre survey that has so far been produced.

Mr. Frank: In the past few months I have witnessed a number of discussions between architects, exhibitors, projectionists, and supply salesmen, with regard primarily to screen size, position, and so forth. At the same time other phases of theatre construction entered. The arguments always center about personal prejudices not based at all upon scientific reasoning. Up to the present it has been impossible for anyone to settle such discussions or arguments authoritatively, and the decision generally is the wish of the exhibitor. Sometimes one or the other can prove that the results on the screen are better under one condition than another. Now, for the first time, the entire industry is in a position to refer to something that is authoritative, something that tells us at least what the existing conditions are.

The Committee, of course, emphasizes that those conditions may by no means be ideal, and we hope in the not too distant future that the ideal conditions will be set forth. But everybody should recognize that now, when we have an argument about how high a screen should be in a theatre, we can at last turn to a document and say to our clients or anyone else with whom we may be discussing the matter, that here is a survey that indicates that the average height of the screen from the theatre floor, throughout the country, is five feet four inches, and merely because an architect wants to put it ten feet high is no reason why he should do so.

We should spread this message as far and wide as we can, to make the greatest amount of use of this very interesting survey.

Mr. Goldsmith: The Committee and the Society should be very proud of one thing, namely, that in this case the industry and particularly the companies that were mentioned, have rallied nobly behind the Society and the Committee. This is one of the finest examples of motion picture industry cooperation with the Society that we have yet had. We are very pleased with this, and think it is an omen of better days.

Borgeson Again Tops Q. and A. Contest

RAGGED performances again marked the papers submitted in answer to the last group but one of Contest questions, the winner, Lawrence Borgeson, alone showing any degree of consistency and thereby registering his second consecutive win over some top-notchers in the craft. And once again the so-called practical projectionists swamped those entries who formerly cut a wide swath through questions based on purely theoretical considerations. The winners:

First Award
LAWRENCE BORGESON
454 El Molino Ave., Pasadena, Calif.

Second Award
H. D. TAYLOR
705 W. South St., Raleigh, N. C.

Third Award
THEODORE P. HOVER
Secretary, L. U. 349, Lima, Ohio

Fourth Award
K. P. KENWORTHY
425 E. Third St., Moscow, Idaho

Instructions accompanying the questions were rather generally disregarded, particularly on that requiring contestants to limit themselves to naming the unit to be inspected for trouble and the type of trouble sought, omitting the details of internal procedure. Many answers, however,

(*Continued on page* 30)

I. A. 34th Convention

By *JAMES J. FINN*

EIGHT hundred and twenty-nine delegates with 923 votes representing 702 locals were present at the Thirty-Fourth Convention of the I. A. T. S. E. in Cleveland, Ohio, the week of June 6—the gathering being far and away the best-organized and smoothest-running conclave of I. A. representatives in the history of the organization, thanks to the unstinting work of locals 27 and 160. On every hand—from the printed program right down the line to farewell courtesies—was evidence of painstaking planning, industrious application and precision execution of the program.

From the standpoint of arrangements and hospitality there never was an I. A. Convention like this one, which is—and may be for a long time to come—the all-time, all-tops and undisputed champ among I. A. gatherings.

There being no election of officers scheduled this year, the highlights of the Convention were contained in the progress reports of the various officers, notably that of President George E. Browne, a detailed resume of which is appended hereto. The Convention opened on a high note as a result of the appearance of such notables as Sidney Kent, President of 20th Century-Fox Corp.; President William Green of the A. F. of L.; Governor Martin Davey of Ohio, the International Presidents of the Plumbers and Steamfitters and the I.B.E.W., and Spyros Skouras, theatre chain operator.

Most interesting statement by Kent was as significant as the appearance of himself and other exhibitors and producers at the Convention:

> "I believe that the record that our industry has compiled, if investigated, would prove that we have had less interruption in employment, less hard feeling, less recrimination, and have built more good will than any industry that I know of in the country."

Gold life-membership cards in Local 160 were presented to President Browne and to his personal representative, William Bioff, by Harland Holmden, Local 160 head. Top-voting Local at Convention was No. 37 with 55 votes representing a membership of more than 7,000.

I.A. Finances, Membership

Report of the Board of Trustees revealed, among other things, following facts: cash on hand, $228,668.65, an increase of more than $137,000 over the previous period; an increased income from per capita tax of more than $128,000; a decrease in operating costs of more than $21,000, and an operating profit of more than $174,000. Cost of the 1938 Convention was approximately $128,000.

I. A. membership has increased over the past two years by 14,004 to a new high of 42,881. New locals chartered total 110. Several stagehand locals have been consolidated with projectionist locals. The Claim Dept. collected $2,998.79 during the past two years, termed a period of "relative inactivity" by Gen. Sec.-Treas. Louis Krouse.

Two past - International Presidents, William C. Elliott and James Lemke, addressed the Convention. Another speaker was Nat Golden, Chief of the Motion Picture Division of the U. S. Dept. of Commerce, who is also a member of Local 160.

The combined report of the proceedings of the various Executive Board meetings that have been held since the last Convention are, of course, the official record of I. A. activities, but since practically the same ground is covered in a more formal and enlightening manner in President Browne's report, the latter will be offered as the *piece dc resistance* of this article.

Browne opened his report with a review of the revolutionary trend in technical and industrial developments within the past ten years. He then paid his respects to the "scurrilous criticism" directed at himself and the I. A. by what he termed the "poison pen" element—which reference obviously was pointed toward certain daily newspaper columnists who have criticized I. A. policies. Browne stated that he chose not to dignify these assertions by entering a refutation, stating that while reams of inferences have been written not a single "implied" fact has been proven.

Strict flexibility still is his policy, Browne stated, and justifiably so in view of the results obtained. Not a single strike or lockout of importance has occurred within the past two years. Browne pointed to such accomplishments as the signing of 38 independent studios in Hollywood, the organization of the film exchange workers, and the settlement of the N. Y. City projectionist controversy in which 160 theatres were brought under the I. A. banner

I. A. Pres. Browne Details Serviceman Organization

EXCERPT FROM PRESIDENT'S REPORT TO 34th I. A. CONVENTION

DISTRIBUTION of applications was the signal for a large group of applicants to form an organization known as the Society of Sound Engineers, with offices in New York, and officers were promptly elected. Before it was possible for the General Office to inaugurate plans, they decided that they would tell us how to organize them; what to bargain for and probably, if given sufficient time, to institute an investigation to decide whether we were fit to be affiliated with.

From a communication sent by the Society to its membership: "Our attorney also read a copy of a letter sent to George Browne, requesting an answer to that letter." They had turned legal even before they had turned I. A. Still another quotation from the same letter: "As you must remember the Society was formed primarily for the purpose of retaining the Sound Engineer's identity as a separate and distinct craft in the motion picture industry and its allied branches."

Special Classification Abolished

I then made up my mind to eliminate "Sound Service" and that these men were to come under the classification of Moving Picture Operators and nothing else. Primarily, because the work is so closely associated, and, further, it is my candid opinion that we have had a sufficiency of local unions with a superiority complex, who feel that they ought to affiliate with the International, giving nothing to the organization and derive all the benefits for which we have long fought. I again immediately went into conference with the Sound Service organizations and agreed upon a basic scale.

This final agreement was not based upon any random guesswork. Each of the Sound Service companies had supplied the General Office with a list of their employes and amount of salaries received, which averaged $57.14 weekly, with unlimited working hours. Consequently, the difficulty encountered by the General Office in obtaining agreement to a maximum of 54 hours weekly with a minimum salary of $80 per week for sound service men working in designated districts, and $110 for those rendering service in unlimited territory. Concisely, this seems to be a fair monetary exchange for a high-sounding title.

Agreement has also been reached for absorbing those men performing sound service work for the major circuits into our local organizations, thus permanently abolishing the "Sound Service" classification.

[EXTEMPORANEOUSLY: "I personally believe . . . that we will not become logs in the pond and will resist every effort to have ourselves put in the position of elevator operators. When the elevator stops, we step out and wait until the man fixes it. I contend now, and I have always contended, that anything pertaining to projection . . . belongs within the scope of our jurisdiction and should be done by our members; they should now, and should have a long time ago, put themselves in a position to proficiently qualify for that class of work."]

by the absorption into Local 306 of a dual organization. He chided certain locals who refused to extend membership to workers in non-union houses through a desire to protect present members. Such theatres, Browne said, are the greatest single factor in the spread of dual unions.

● Coast Studio Situation

Referring to the West Coast studios, the I. A. President said that in 1934 the total membership in all Hollywood locals was 158, with dissension and chaos rife even among those few. He defended continued I. A. control over all studio locals from 1934 until now, and in the future, by asserting that producers had flatly refused to deal directly with local union officers, and that the latter, in fact, had then and still do prefer International control. Criticism concerning the addition of many new classifications among studio locals was unwarranted, said Browne, only one new classification having been added to Local 37 and that in Class B. Two new studio charters have been granted to makeup artists and to costumers, both by unanimous petition of the memberships.

Browne stated that investigators for the California State Legislative committee had given the I. A. a clean bill of health as to policies and practices following an intensive examination of Alliance officials and records. A subsequent poll of all Coast members resulted in overwhelming approval of International control. Browne charged the C.I.O. with instigating the investigation. Criticism in union circles and in the press of I. A. "grabbing" jurisdiction in the industry was proven baseless in the light of the Alliance jurisdictional award from the A. F. of L., asserted Browne, who continued:

"Much of the criticism . . . is due to the fact that other Internationals who usurped much of our work after the strike of 1933 now resent us claiming our proper jurisdictional rights. For instances, the Carpenters had taken over the prop-making and grip work; the I. B. E. W. took over the sound work; the Painters held control over the Makeup Artists and Hairdressers, and the Laborers and Hod Carriers had taken over whatever work the others did not grab."

Browne shied away from any extensive discussion of the current Guilds-I. A. controversy by simply stating that the I. A. has many voluntary petitions from members of Guilds and other Internationals for affiliation with the Alliance. The I. A. intentions in this direction, therefore, are as much as secret as heretofore. Inclusion of the I. A. emblem on credit titles was held to be of enormous value as a prestige-builder. Local autonomy has been restored to Kansas City L. U. 170, Gary Local 145, and South Bend Local 496, both in Indiana. Pittsburgh, Pa., Local 171; St. Louis Local 143, and N. Y. Lab. Local 669, in addition to all studio locals, remain under International supervision.

Canadian conditions, while reflecting no spectacular advances, show promise of improvement, said Browne, who admitted that every conceivable remedy applied to the situation in the Province of Quebec has been of no avail. Montreal has been locked out since 1937.

● New Classes Organized

Signaturing of the national closed-shop exchange workers contracts culminated a long period of organization designed to not only strengthen the I. A. but to bar the path of other labor outfits into the picture field, asserted Browne, with the same reason advanced for organizing front-of-the-house workers. The latter group constituted a tough nut to crack, said Browne, who confessed being a trifle bewildered by having to bargain for from $10 to $18 weekly for employees among whom there was an annual labor turnover of 40%.

Regarding sound system servicemen, the I. A. President revealed the reasons for the switch in organization policy after the last Convention, at which time plans were set for a separate Sound Service Division within the I. A. These circumstances are detailed elsewhere in this article.

Pressure of I. A. work was the reason advanced by Browne for his much-discussed abortive resignation as an A. F. of L. vice-president early in 1937. Shortly thereafter the cleavage in Labor ranks became pronounced and, he said, he was prevailed upon to reconsider his resignation.

Frank admission of his doubts that the stage will ever attain a position comparable with its previous high standing was voiced by Browne, who cited a stricter enforcement of regula-

(Continued on page 29)

General view of assembly at the I. A. 34th Convention in the Cleveland Public Auditorium

Academy R. C. Nomenclature For Release Print Sound-Tracks

By *JOHN K. HILLIARD**

RECENT use of push-pull and squeeze-tracks in variable-density recording, as well as the modifications of the aperture used in variable-width recordings, have led to the appearance on release prints of several new and different types of sound-tracks. For this reason these tracks are illustrated and the type of equipment necessary for their projection designated, in order to lessen confusion in their use and help in standardizing their nomenclature.

All types of variable-width tracks can be distinguished from variable-density tracks by the fundamental difference between the two, namely, that the variable-width tracks consist of opaque and transparent portions extending along the length of the film, with the two portions separated by a dividing line that constitutes an oscillogram of the signal; whereas variable-density records consist of alternating dark and light portions extending across the track and merging gradually into one another. Although there will be differences within any one type, this primary distinction between the two types is easily discernible.

Within each general type of recording, each particular form of track is considered from the standpoint of the type of reproducing equipment necessary for its reproduction, and then from the nature of the track itself and the manner in which noise-reduction has been applied. The various tracks are illustrated and their nomenclature given, and

*Metro-Goldwyn-Mayer Studios, Culver City, Calif. Chairman, Committee on Standardization of Theatre Sound Projection Equipment Characteristics, Research Council, Academy of Motion Picture Arts & Sciences, Hollywood, Calif.

FIGURE 1
Single variable-density

FIGURE 2
Single variable-density squeeze, showing transition from full-width to squeeze-track

FIGURE 3
Single variable-density double squeeze, showing transition from full-width to double squeeze-track

FIGURE 4
Push-pull variable-density

then the manner of choosing the respective names explained.

● Variable-Density Tracks

A variable-density record to be reproduced on a standard reproduction system of sufficient power for the auditorium under consideration is illustrated in Fig. 1. This track is a single low-frequency note, but all signals, no matter how complicated, will consist of alternate dark and light striations, the complexity of the signal merely resulting in a non-uniformity from point to point along the length of the track. Such a record, called *Single Variable-Density*, covers the whole width of the track, and, although noise-reduction may have been applied during recording, it is not easily discernible and is unimportant for nomenclature purposes.

Figure 2 is a sample of *Single Variable-Density Squeeze-Track*, and may be reproduced on any standard reproducing equipment of sufficient volume range, as explained in another paper.[1] The upper portion is a *Single Variable-Density Track* of the usual 100-mil. width to which noise-reduction in the form of squeeze has not been applied.

The center section shows the manner in which the V-shaped mask affects the recording beam and reduces the track width. The lower portion illustrates a track reduction of 75 per cent, or 12 db. The usual reductions in track width used are reductions to 25 and 50 per cent of the original track width—reductions of 12 and 6 db., respectively.

The track shown in Fig. 2, is termed *Single Squeeze-Track* to differentiate it from the track shown in Fig. 3, which is double-squeeze. This track, called *Single Variable-Density Double Squeeze-Track*, may be reproduced on any standard system having adequate volume range.

This form of track is obtained by using a mask in the form of a *W* inserted in the recording beam in the same manner as is the *V* mask for a single squeeze-track. As the mask takes effect, the track is reduced in the center as well as at the sides, as shown, and a bilateral, or double, track results.

Although this track, during the period of operation of the *W* matte, is a bilateral track, it is termed *Single Variable-Density Double-Squeeze*, as the word "single" refers to the fact that it is recorded by a two-ribbon valve and is fundamentally a normal variable-density track made bilateral by the addition of the matte in the recorder.

In studio work where a 200-mil track is often used, one-half of such a push-pull track (termed *Wide Push-Pull*) has the same appearance as a single variable-density track; while one-half of a wide push-pull double squeeze-track will have the same appearance as a single variable-density squeeze-track. To avoid any such confusion when using this nomenclature, the term *Single* has been

FIGURE 5
Push-pull variable-density squeeze, showing full-width track, double squeeze of 6 db., and double squeeze of 12 db. *(Upper)* no squeeze; *(Middle)* 6 db. squeeze; *(Lower)* 12 db. squeeze

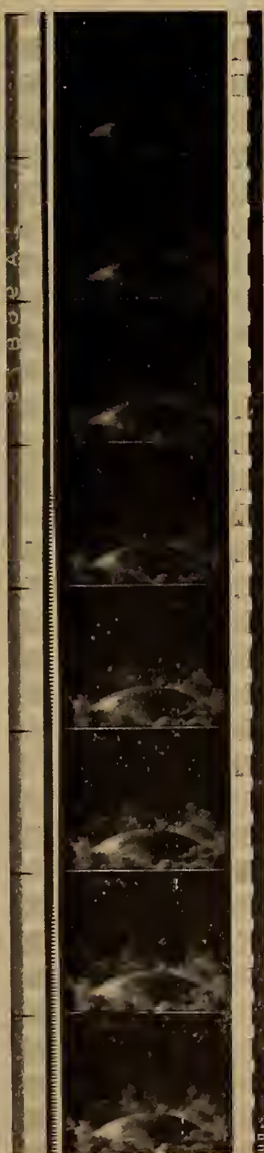


FIGURE 6
Unilateral variable-width

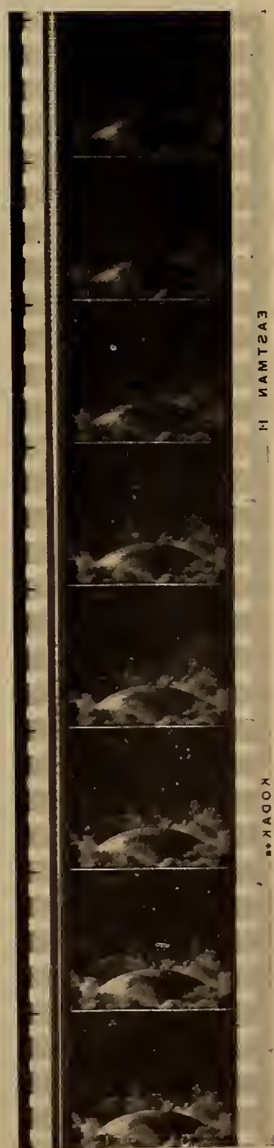


FIGURE 7
Bilateral variable-width

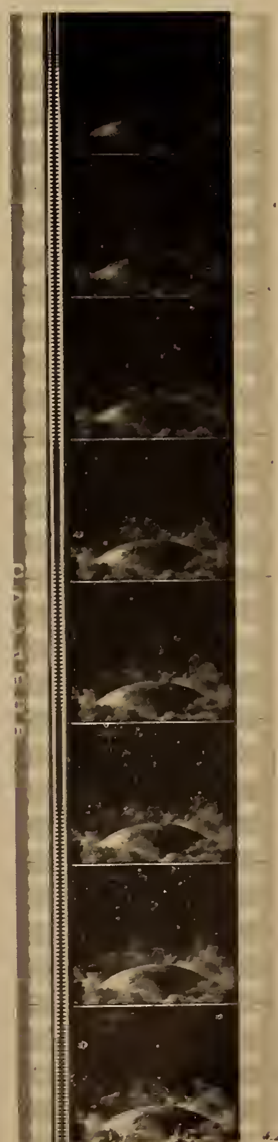


FIGURE 8
Duplex variable-width

applied to the tracks recorded with a two-ribbon valve, and the term *Push-Pull* to tracks recorded by a four-ribbon valve.

● Push-Pull V. D. Tracks

Figure 4 is a sample of a *Push-Pull Variable-Density Sound-Track;* and Fig. 5 illustrates a *Push-Pull Variable-Density Squeeze-Track,* either of which can be reproduced on any system of sufficient volume range for a squeeze-track, provided the system includes a push-pull photocell. Push-pull records consist of two tracks divided by a septum or center line, with the two tracks 180 degrees out of phase. When double squeeze is applied to a push-pull record the septum is broadened and the other edge of the track carried toward this septum.

Push-pull tracks may be distinguished from standard tracks, regardless of whether or not squeeze has been applied to either or both these tracks, by the fact that in the former the two tracks are 180 degrees out of phase; that is, considering a lateral cross-section of the two push-pull half-tracks, a dark portion on one half-track will be opposite a light portion on the other half-track (Figs. 4 and 5). On a single track, which is bilateral as a result of double squeeze, light portions are opposite light portions, just as the dark portions are opposite one another (Fig. 3).

The term "push-pull," applied to either variable-width or variable-density, refers only to Class *A* push-pull records, for the reason that, in the present stage of the reproducing art, Class *B* push-pull tracks are impracticable from a commercial standpoint, and, as a consequence, are not used. If at any future date it is necessary to include Class *B*, the terms Class *A* and Class *B* will then be included in the nomenclature.

● Variable-Width Tracks

This type of track, as previously explained, may easily be recognized by the fact that the opaque and transparent portions of the track extend along the length of the film—in contrast to the variable-density record, in which the light and dark portions extend laterally across the film.

Figure 6 illustrates a single-envelope variable-width track in which noise-reduction (reduction in width of the transparent portion of the track) has been accomplished by the application of the shutter method. Consequently this track is termed *Unilateral Variable-Width.*

Figure 7 illustrates a *Bilateral Variable-Width* track, so-called because it is a double-envelope track on which noise-reduction has been accomplished by means of bias current on the galvanometer. Fig. 8 illustrates a *Duplex Variable-Width* track, which is also a double-envelope track in which noise-reduction has been accomplished by means of a double shutter, each shutter acting from one edge of the sound-track and both shutters actuated by part of the signal current.

The tracks illustrated in Figs. 6, 7, and 8 may be reproduced on any reproduction equipment with sufficient power for the auditorium under consideration.

Figure 9 illustrates a *Push-Pull Variable-Width* track, which may be reproduced on any equipment of sufficient power, provided the equipment has a double or push-pull photocell.

Push-pull variable-width tracks may be distinguished from other variable-width forms of recording in the same manner as the variable-density recordings are distinguished: that is, by the fact that the two half-tracks of the push-pull track are 180 degrees out of phase.

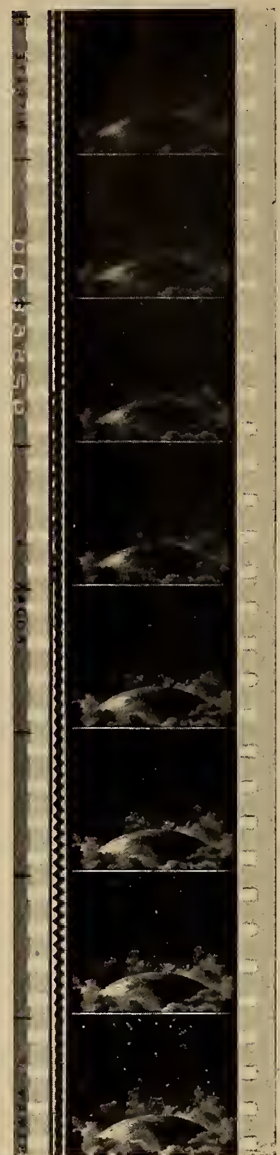


FIGURE 9
Push-pull variable-width

[*Editorial Note: Formal approval has been given to the proposed nomenclature by the Academy of Motion Picture Arts & Sciences. This nomenclature is being submitted to the Sectional Committee on Motion Pictures of the American Standards Association, for approval as an American Standard.*

A digest of these nomenclature specifications is appended hereto. The figure numbers correspond to the illustrations mentioned in the paper immediately preceding.]

ACADEMY STANDARD NOMENCLATURE FOR RELEASE-PRINT SOUND-TRACKS

Plays in "Std." Position of Sound-Head Switch

Single variable-density	Fig. 1
Single variable-density squeeze	Fig. 2
Single variable-density double squeeze	Fig. 3
Unilateral variable-width	Fig. 6
Bilateral variable-width	Fig. 7
Duplex variable-width	Fig. 8

Plays in "P.P." Position of Sound-Head Switch

Push-pull variable-density	Fig. 4
Push-pull variable-density squeeze	Fig. 5
Push-pull variable-width	Fig. 9

Classification as to Recording

Figures 1, 2, 3, 4, and 5 illustrate the different types of variable-density sound-tracks; while Figs. 6, 7, 8, and 9 illustrate the various variable-width tracks.

Classification According to Power Requirements Necessary for Undistorted Reproduction

Those tracks illustrated in Figs. 1, 4, 6, 7, 8 and 9 may be reproduced on those systems having a volume range that was considered adequate up to the present time and prior to the installation of the modern improved equipment with its relatively greater amplifier power.

Classification by Type of Equipment Necessary for Reproduction

"Push-pull" tracks as illustrated in Figs. 4, 5, and 9 can be reproduced *only* on systems having a double, or "push-pull," photocell, together with the necessary associated circuits.

Figure 5 illustrates the different amount of "squeeze," or track reduction, now being applied to variable-density recordings. The upper portion of this figure shows a "push-pull" track before the application of any "squeeze"; the center portion a reduction in track width of one-half; and the lower section a reduction of three-fourths, these being reductions of 6 and 12 db., respectively.

Extend Low-Price Offer On Academy Book

So widespread is the interest among projectionists in the new Academy book, "Motion Picture Sound Engineering," that an extention of the special pre-publication price of $4 has been arranged exclusively for members of the projection craft. In the studio field the price of this book was advanced on June 15 to $6.50; but the special low rate of $4 will be honored on all orders from projectionists which are postmarked not later than July 15. Orders should be sent direct to the Academy, Taft Bldg., Hollywood.

The book has been adopted as the official text for Los Angeles high and trade schools.

Emergency Measures Applicable to Sound System Power Failure

By *LAWRENCE BORGESON*

PROJECTIONIST, FOX TOWER THEATRE, PASADENA, CALIFORNIA

The type of sound reproducing equipment discussed in this article, while not measuring up to the standard set by recent systems, still is widely used in theatres. Sound outage on such equipments are much more common than on modern units, thus the urgent need for a thorough knowledge of procedure for restoring the show in the least possible time. This article seeks to meet this requirement.

WHEN some unit of projection equipment fails to operate, the projectionist naturally desires to get an acceptable performance back on the screen within a minimum period of time. While extremely dependable as a rule, sound system parts can occasion complete outage of sound in the event they become inoperative. The low-voltage, direct-current power supply is case in point.

This power supply consists in some theatres of a set of batteries; an 18-volt d.c. generator in others, and in still others, tungar rectifiers. In case of failure, there are a number of possible procedures to temporarily replace this low-voltage source, and it is the purpose of this paper to discuss three emergency measures, at least one of which may be used. The first method described is the most desirable from the standpoint of voltage regulation and quietness of operation. The third, however, is one which can be quickly applied, thus allowing the show to continue with the least delay.

● Battery Operation

The exact voltages required will vary with different theatres, depending upon the type of power source normally used. We will assume that a theatre is equipped with an 18-volt d.c. generator which has failed completely due to some cause in the motor, its starting unit, or the generator itself. We will assume further that all other parts of the sound equipment have been unaffected. In order to restore the show, an 18-volt power supply will have to be obtained to furnish current to the horn fields, the exciting lamps, and the filaments of various vacuum tubes.

The most satisfactory temporary supply would be batteries, if they were easily obtainable. The total number of 6-volt storage batteries which would be required depends upon two things: first, the number of hours they are to be used, and second, the current drain to be expected. The current taken by the sound system can be estimated fairly accurately by adding up that taken by the exciting lamps, the filaments, and the parallel horn field circuits, plus about 25 per cent of this total as an estimate of the current which passes through the various bleeder resistances in the filters.

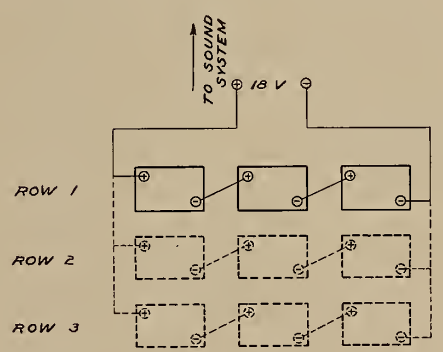


FIGURE 1

At least three 6-volt storage batteries would be required in order to get 18 volts. The method of connecting them is shown by means of the full lines in Fig. 1. The dotted lines represent the manner of connecting additional batteries, if needed. The number of rows, of three batteries in series (3 for 18 volts, 4 for 24 volts, *etc.*), required for a given theatre can be calculated readily from the following formula:

$$(1)\quad \text{Rows} = \frac{H \times A}{W}$$

where H = total number of hours battery will be used,
A = the amperes taken by the sound system, determined as explained previously,
W = the ampere-hour rating of a single storage battery.

For example, suppose the sound system takes 15 amperes, and the batteries are to be used for ten hours. If the storage batteries were rated at 100 ampere hours each, then:

$$\text{Rows required} = \frac{H \times A}{W} = \frac{10 \times 15}{100} = 1.5$$

Therefore, two rows of batteries would be required (six batteries in all for 18 volts) in order to maintain voltage and quietness of operation to the end of the ten-hour period.

Probably the most satisfactory place to connect the battery bank to the sound system would be at the junction box which is usually located on the wall beside the 18-volt generator. The battery leads should be connected to the two wires in the box which go to the sound system. The wires which normally go to the generator

FIGURE 2

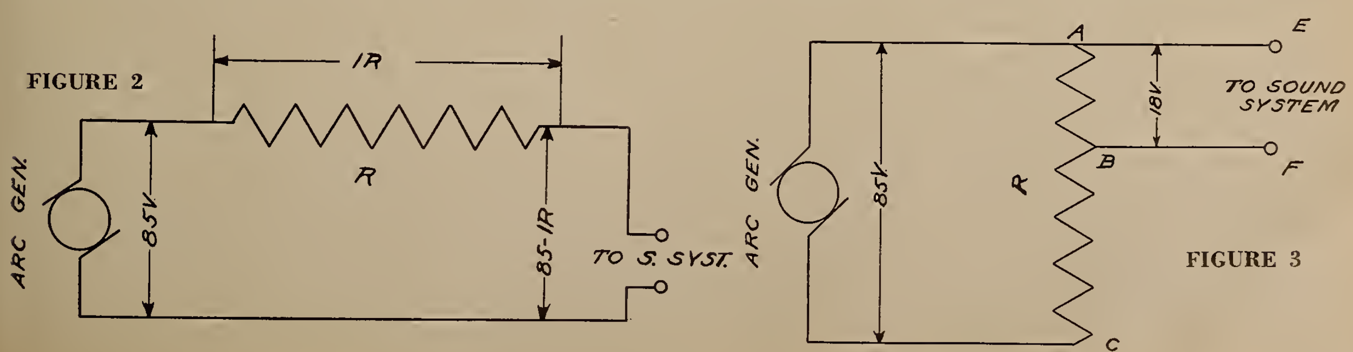


FIGURE 3

should be disconnected in order that this machine will not act as a load on the batteries. Before soldering, the connections should be checked for polarity. Note that the filters still will be in the circuit. This is necessary, in many cases, since the filter units contain shunt resistances and voltage-dropping resistors which must remain in the circuit if the proper potentials are to be applied to component parts of the system.

While the aforementioned arrangement offers a constant voltage source and one which has no ripple voltage to cause hum, it does have the disadvantage of requiring considerable time, in many instances, to obtain the necessary number of storage batteries.

● Use of Arc Generator

The second method of temporary operation makes use of the arc generator. Many of these machines in theatre use have output voltages of 70 or more to the buss. In dropping this relatively high voltage to 18, in order that it may be used, it is as necessary to know which methods *not* to use as it is those to use.

The average projectionist, in a hurry to re-establish operation, might, without thinking, conclude that all that is necessary is a resistance in series with the sound set. Inspection of Fig. 2 will show the fallacy of any such procedure. The figure represents an 85-volt arc generator connected to the 18-volt lines of a sound system, with a resistor R in series. To illustrate the point, let us assume that the normal current taken by the sound set is 13.5 amperes. Then the resistance R will be 4.9 ohms. The drop, under normal conditions, across resistance R will be 13.5 x 4.9, or 67 volts. The voltage applied to the sound system will be 85 minus 67, or 18 volts.

Now, suppose that an exciting lamp taking 3.5 amps. is turned off or burned out. The current through R would then be decreased to 13.5 minus 3.5, or 10 amperes, and the drop across the resistor would then by 4.9 x 10, or 49 volts. The voltage applied to the sound system under such a condition would be 85 minus 49, or 34 volts. 34 volts instead of 18! Obviously, the result would be disastrous. *Never* use a series circuit like that shown in Fig. 2.

Figure 3 shows a method of using the arc generator that will be safe, if the proper value of resistance R be used. (R is the total resistance shown between the points A C of Fig. 3.) Its magnitude should be such that the current through B C is at *least* three times the current supplied to the sound system. This is necessary in order that the voltage across the sound terminals E F shall not vary too much with change in load to the sound system. R should be equal to, or less than, the value in ohms calculated by formula 2.

$$(2) \qquad R = \frac{2E + V}{6I_s}$$

where

R = the resistance to be determined (between A C, Fig. 3),

E = arc generator voltage (terminal),

V = sound system voltage,

I_s = sound system current.

In addition, the resistor must have a wattage rating of at *least* as great as is given by formula (3).

$$(3) \qquad W = \frac{3\,I_s}{2}\,[2E + V] \text{ watts}$$

To illustrate the use of (2) and (3), let us assume a sound system will take 15 amperes at 18 volts. If the terminal voltage of the arc generator be 85, then:

E = 85 volts
V = 18 volts
I_s = 15 amperes

therefore

$$R = \frac{2E + V}{6I_s} = \frac{(2)\ (85) + (18)}{(6)\ (15)} = \frac{170 + 18}{90}$$

$$\text{or, } R = \frac{188}{90} = 2.09 \text{ ohms.}$$

The wattage rating of the resistor R would have to be at least:

$$W = \frac{3}{2}(15)\ [(2)\ (85) + (18)] = (45)\ (94) = 4230 \text{ watts}$$

The manner of connecting to the sound system is the same as in the third method discussed hereinafter.

This second method has certain advantages and disadvantages. The picture can be back on the screen with very little delay, and after the connections are once made the projectionist's attention is no longer required; but the arc generator rating must be high enough to supply this extra continuous load (three times sound system current) and, in addition, a high-wattage resistor is necessary. Many theatres do not have the generator capacity or the resistor required available; but many of these theatres would be able to operate under the third method now to be discussed.

● Arc Ballast Resistors

Instead of using such a resistor as R aforementioned, the actual arc ballast resistor shown in Fig. 4 may be used. Here A_1 C_1 and D C_2 represent the ballast resistors of the arc circuits for machines 1 and 2, respectively. S is a double-pole, double-throw switch, the center points of which are connected to the sound system. The other contacts are connected to the arc ballast resistors as shown. The procedure in making the connections is as follows:

1. The sound system should be disconnected from its generator and

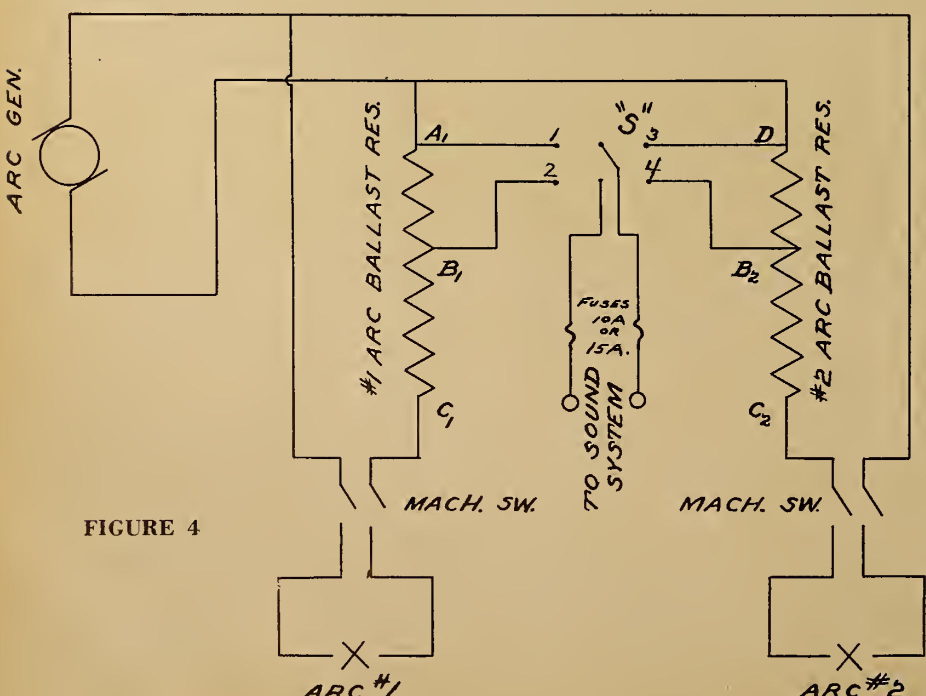


FIGURE 4

reconnected to the center poles of the d.p.d.t. switch, with fuses inserted as shown. The fuses should be rated at 15 amperes or less, depending upon the normal current taken by the sound system.

2. Connect a wire from contact 1 of switch S to point A_1 on the No. 1 arc ballast resistor.

3. Connect a voltmeter to the knife blades of S.

4. Start arc No. 1 burning, and then throw switch S to the left hand position, *i.e.*, closing it with the contacts 1 and 2.

5. Take wire connected to contact 2 of switch S, and, starting at point A_1 on the resistor, slide it along towards C_1 until at some point B_1 the voltmeter reads 17 volts; then make a permanent connection at B_1.

6. Start No. 2 arc burning and throw switch S to the right, thus having the switch blades contact 3 and 4.

7. Connect the wire from point 3 of the switch to point D on No. 2 machine arc ballast resistor.

8. Take the wire connected to contact 4, and slide it along the resistor from point D until at some point B_2 the voltmeter reads 17 volts.

The system is now ready to operate. It will be noted that in (5) and (8) above the voltage is adjusted to 17 volts, which is one volt below normal. Such a procedure is recommended, since there is a certain amount of voltage regulation. If the system be connected in this manner, and if the sound system load be reduced as much as 30 per cent, the voltage will not rise over 18 volts, thus avoiding the danger of overvoltage.

In operating under these conditions, it will be necessary to throw switch S after each change-over to the ballast of the machine running in order that the sound will not stop when the outgoing arc is turned off. It is suggested that the arc be started *before* connecting the sound system to the ballast resistor, to prevent high voltage across the system when the arc is struck. In many instances no trouble would be encountered; but in other cases the voltage would be excessive and the fuses shown in Fig. 4 would be blown. Therefore, as a precautionary measure, connect the sound system to the ballast by means of switch S *only after the arc is burning.*

This third method requires a minimum of extra equipment (a distinct advantage in most theatres) and, in addition, requires very little time to resume operation. Its main disadvantages are:

1. Care must be taken to see that the sound system is disconnected from the arc ballast when the arc is struck.

2. There is a certain amount of voltage regulation, not experienced when storage batteries are used.

3. The picture arc current will rise (sometimes as much as 10 per cent) because the sound system is in parallel with part of the ballast resistor, therefore the total resistance of the arc circuit is reduced slightly. If a variable arc ballast resistor be used, it can be adjusted to give the normal arc current. However, a slight increase in arc current will not be a particular handicap.

Herein have been described procedures which might be followed when a sound generator fails, but they are also adaptable, with certain changes, when either rectifiers or batteries fail. In the case of a tungar rectifier, the usual buss voltage is 24, so it will be necessary to adjust the external emergency source to 24 volts rather than 18; but this can be done easily.

It is impossible to describe in detail herein the exact procedure for every kind of equipment. but the ideas presented can be modified to meet particular needs.

STUDIO PROJECTOR CHANGES CITED IN ACADEMY REPORT

MODIFICATIONS made in studio projection equipment to prevent rotating parts from scratching prints is summarized in a recent report by the Research Council of the Academy of M. P. Arts & Sciences. Credit for the work goes to the Warner Brothers and 20th Century-Fox studios. The adoption of these modifications by the studios is expected to result in a considerable economy due to the elimination of damage from print scratches. Details follow:

1. Intermittent and upper and lower sprockets relieved to the tooth base on the insides of each sprocket.

2. All pad rollers and idler rollers are relieved where required. Those which have double flanges have had the inside flanges turned down flush with the center diameter of the roller.

3. In all instances, sprockets and rollers are relieved on each inside edge to permit of their being reversed to secure longer life after tooth and flange wear.

4. A flanged guide roller is installed above and to the left of the fire-trap in the upper magazine. The film passes under this roller as it leaves the reel and is guided through the fire-trap rollers to prevent those rollers from scratching the film due to excessive weave caused by bent reels, spindles, *etc.*

5. The lower small roller in the fire-trap of the takeup magazine has been replaced by the flanged guide roller to prevent the film weaving through this fire-trap because of bent takeup reels, spindles, *etc.* To allow threading through the fire-trap with this roller installed, the fire-trap casting is cut away on the front side so as to greatly widen the present threading slot.

On RCA sound heads, all constant-speed and hold-back sprockets are relieved.

20th Century-Fox have altered all equipment by exactly similar methods to those used by Warners in every case, except that instead of placing a roller in the lower magazine fire-trap, a flange roller has been placed just outside the fire-trap which acts as a guide for the film and leaves the fire-trap as originally constructed.

S.M.P.E. MEET IN DETROIT

The Fall Convention of the S.M.P.E. will be held in Detroit, Oct. 31 to Nov. 3. General convention facilities will be at the Statler Hotel, S.M.P.E. headquarters, Karl Brenkert is chairman of the local arrangements.

NEW FOREST DEALERS

The following have been appointed exclusive authorized dealers for all Forest Mfg. Co. products, including magnesium copper-sulphide rectifiers:

Central Thea. Equip Co., Kansas City, Mo.; Breck Photoplay Supply Co., Los Angeles, Calif.; Western Theatre Equip. Co., San Francisco, Calif.; Walker Cottrell, Jr., Richmond, Va.; C. W. Neuhardt & Son, Wheeling, W. Va.; and in Portland, Ore., Seattle, Wash., and Butte, Montana, the Western Thea. Equip. Co.

I. A. 34th CONVENTION

(*Continued from page* 21)

tions, commercials using stagettes, and p. a. set work as a means of offsetting stagehand unemployment. He asked also that projectionist locals co-operate at every turn with stagehands, although he did not advocate widespread withdrawal of projectionists from p. a. and similar jobs.

One extremely significant portion of Browne's report was that following his expression of thanks to the locals for their aid in casting aside precedent in the organization of sound servicemen. He said: "Its future possibilities, which I am not free to discuss at this time, hold much promise. It is no trick at all to interpret this comment in terms of using the sound servicemen as a base for an excursion into the radio and television fields."

Browne promised that the I. A. would pursue relentlessly its organization of the commercial motion picture field, including all 16 mm. operation.

● Action on Resolutions

The Grievance Committee might just as well not have been appointed, for not a single case came before it, an unprecedented occurrence at I. A. conventions. Among those resolutions presented to the Convention were the following:

Proposal for group insurance covering every I. A. member in the amount of not more than $1,000 and not less than $500; referred to Executive Board. Request that I. A. act to prevent general public from attending Army post theatres, and to secure such work for I. A. members; referred to General Office. Expression of opposition to propaganda in films glorifying or encouraging any form of government other than that of U. S.; adopted. Request for financial and moral assistance in defeating proposed California legislation favoring incorporation of labor unions; adopted.

Also, petition from member of "I. A. Progressives" group on West Coast charging undemocratic procedure in I. A. handling of Coast locals, intimidation and coercion, and requesting return of full local autonomy; Resolutions Committee recommendation that International President institute sweeping investigation of "Progressives" group and, if warranted by the evidence thus uncovered, prefer charges against them, was adopted by Convention. Proposal that I. A. pay weekly strike benefits of $15 to married men and $10 to single men; disapproved. Request that I. A. label be placed on all newsreels, shorts and commercial films, and that film bearing such label be processed only in I. A.-organized laboratories; referred to Executive Board. Resolution that all I. A. Locals be instructed that all films, irrespective of size or nature, bear I. A. cameraman emblem, otherwise not be shown by I. A. projectionists; referred to Executive Board.

Also, an appeal by N. Y. City delegates that the I. A. complete the organization of N. Y. City theatres; referred to Int. Pres. Request that the I. A. register opposition to inclusion of Coast Guilds under protection of

National Labor Relations Board, and that the A. F. of L. be requested to declassify such Guilds as labor organizations by revocation of charters and withholding of all support; approved.

BORGESON AGAIN TOPS Q.&A. CONTEST; WINNING ANSWERS

(*Continued from page* 19)

actually gave more attention to such internal work than to the external process of eliminating other components by logical analysis.

Even the winning answers are not entirely free from traces of this fault. Some letters went to the opposite extreme by disregarding the external work and citing in detail the procedure within a given component, on the mere hunch that that might be the component at fault.

Another instruction, requiring answers to be based on the apparatus diagrammed, was also largely overlooked. In fact, R. A. Young put himself out of the running by stating specifically that his answers were based on *his own equipment.* Leo Cimikoski based his answer to Question 20 on a drawing which appeared on page 25 of I. P. for April, 1938, which drawing was part of the answer to Question 12 of the previous month's contest.

Contestants whose replies, as a whole, did not rate as high as the winning answers, not infrequently scored points that the latter overlooked. Thus in answer to Question 17, Theo. P. Hover notes that smoking or serious overheating of No. 2 exciter supply unit is sufficient cause to suspend further trouble-shooting, run an emergency line from No. 1 unit, and keep the show running while No. 2 cools sufficiently to permit work on it. T. Morisawa points out that an exciter supply line can be checked with a buzzer alone, since its voltage is low enough to make the buzzer sound without burning it out (which depends on the type of buzzer).

C. E. Mervine brought out two interesting points in answer to Question 17: namely, if a jumper to No. 1 exciter supply is needed for emergency action, a single wire will be adequate in most systems, the negative return being taken care of by the common ground. Also, while many contestants pointed out that such a jumper required unplugging or switching off the unused exciter lamp to avoid over-straining No. 1 power supply unit, only Mr. Mervine noted that doing so would cause a thump in the sound, and that the unplugging process should therefore be handled while the fader is at zero during changeover.

Still further in answer to Question 17, while many contestants suggested transferring the reel to No. 1 projector before continuing to run down the trouble, Earl H. Griffen alone noted that this step is undesirable if there is not much film left in the upper magazine. The winning answer to Question 19 overlooks the possibility of speaker defects, such as a defective field winding or inoperative hum buckling coil in the speaker, or a rattle in the speaker mounting which simulates hum.

The winning answer to Question 20 overlooks the possibility tbat the h.f. speakers may have swung out of proper placement, does not mention exciter lamp filament sag or faulty lateral light adjustment as possible trouble causes, and fails to note that the normal show may be restored, pending trouble-shooting, by temporary readjustment of the filter network settings.

17. Sound stops with No. 2 projector in operation. A glance at all tubes and exciting lamps in the projection room shows every filament lit normally except No. 2 exciter lamp. A new lamp installed in No. 2 fails to light. What

would you do to restore the show in the fastest possible time?**

By LAWRENCE BORGESON

Since all tubes are said to be burning normally, we assume that those in the monitor amplifier are also burning. This being the case, the fuse shown in Fig. 2 will be O.K. therefore I would:

1. Replace the fuses in the exciting lamp supply shown in Fig. 1, if this unit contained fuses and they were burned out.
2. If the fuses were o.k., and that unit contained rectifying tubes, I would replace them.
3. If still no light I would quickly inspect this exciting lamp supply shown in Fig. 1 for loose connections or other abnormalities, such as excessive heating, *etc.*
4. If these measures did not help, I would return to No. 2 projector and quickly inspect the exciting lamp compartment for broken wires, loose connections, *etc.*

If the trouble had not been determined, or if it had and it would require some time to repair, I would proceed to 5 below. Steps 1-4 could be taken quickly with only a short stop. If the apparatus to be inspected is so located that some time will be required to carry out 1-4, proceed to 5 immediately, and then make tests 1-4. Circumstances dictate the exact procedure to be followed. In any event, I would try to keep the stoppage time to a minimum and to limit the interruptions to one.

5. Put the film from No. 2 machine in No. 1 and proceed with the show; then
6. Check the input to the exciting lamp supply unit with a voltmeter or test lamp; if "dead," the connections at this supply input and at the fuse block shown in Fig. 2 would be checked, since there is an open circuit between these two points. There is not a ground between these points, else the fuse in block 2 would have been blown.
7. If test 6 showed power input to the supply, I would make the following tests—

If a contact rectifier in the unit:

a. Test the output with a low-voltage test lamp or voltmeter.
b. If "dead," there are loose connections, broken wires, or loose stacks in the unit.
c. If "alive," go to 8 following.

If a tube rectifier of some type:

a. Apply a low-voltage test lamp (such as an exciting lamp) to output.
b. If dead there are loose connections, burned out internal resistance, burned out transformer, or shorted filter condenser.
c. If output tests o.k. proceed to test 8.

If a.c. transformer in the supply for reducing voltage, and output is a.c. to lamps:

a. If the output tests dead there are broken wires, loose connections, or a burned out transformer in the unit.
b. If output tests o.k. I would go to test 8.

8. Test input to the exciting lamp compartment on machine with a low-voltage test lamp. If "dead," there is an open circuit between sound head and exciting lamp supply unit, due to loose connections or broken wires.
9. If test 8 shows power to the compartment, then there is an open circuit due to broken wires, loose connections, *etc.*, within the compartment. The exciting lamp socket may be defective. (It is assumed that the second exciting lamp was alright, of course.) Having located any of the aforementioned troubles, I would repair them, if possible. If some indispensable unit were irrepairably damaged, it would be necessary to bring in an external voltage in order to keep No. 2 machine running, until a spare part could be obtained.

18. A preliminary check in the morning shows no sound, either in stage or monitor speakers. Tests show system is unresponsive to input from either projector. State the possibilities

in the order in which you would check them for quickest results.

By H. D. TAYLOR

Total sound outage in a sound system would be caused by "A" failure in a section of the signal circuit, including control panels, amplifiers, *etc.*, that is common to all the inputs and speakers. This portion of Fig. 1 is from the input of switching panel to the point where the monitor amplifier circuit branches off. "B" failure of a power source or its connecting wiring, that furnishes voltage or power to the portion of the system that is common to all inputs and speakers.

To locate cause for complete loss of sound from both projectors in a system represented by block schematics of Figs. 1 and 2, I would proceed by steps until the trouble was found, as follows:

1. Recheck all switches to be sure that the system is properly switched on.
2. Switch on announcing system and test for sound at the input.
3. See that line voltage is applied. To check voltage amplifiers line fuses of Fig. 2 switch on No. 2 projector motor. If one or both of the power amplifiers' power supplies furnishes potentials for sound heads and/or voltage amplifier, check their line voltage by examining their filament current or voltage meters, or their line fuses of Fig. 2.
4. Check tubes of voltage amplifier. Plate current meter would lead to disclosure of shortage of d.c. potentials from external source. If no plate current meter is wired in voltage amplifier, check socket voltages.
5. Test through switching panel for faulty contacts or connections.
6. Check d.c. potentials from external source at sound heads.
7. Check output of voltage amplifier for sound with headset. For sound, find open between output and monitor branch circuit. For no sound at output, disconnect one side and check. If sound is now heard, check all output wiring, including monitor branch circuit and input of filter network for a short or a ground. If no sound still is heard, connect output and proceed.
8. Normal input at voltage amplifier is most likely too weak to operate headset. In this case disconnect one side of input and check wiring between input and switching panel for open, short or a ground. The switching panel and wiring between panel and junction of Nos. 1 and 2 control panels have already been checked by tests 2 and 5. If all input wiring is found to be o.k., service all speech circuits through voltage amplifier, including primary of input transformer, if used, and secondary of output transformer. Trouble may be further isolated in amplifier by touching or grounding each control grid beginning with the first tube, until results are heard in speakers.

When looking for shorts or grounds in speech circuits, sharp ends of lead shielding penetrating wire insulation are a common cause.

19. The management reports hum in the low-frequency speakers only. Disregarding ground troubles, state the procedure you would follow.

By LAWRENCE BORGESON

A. Turn up the monitor volume to see if hum is present there. If it is, then the source is ahead of this point. I would try to determine by the sound the approximate frequency and, if possible, the probable source, such as sprocket hole, dividing

lines, machine vibration, *etc.* Since the frequency of these sounds is predominantly below the cross-over point of the usual system, the hum would be heard appreciably through the low-frequency horns only. If the hum was heard, but the source indeterminable, I would:

1. Inspect the meter readings of the voltage amplifier for abnormalities, principally for unbalanced rectifiers.
2. Push slightly against the edge of the film at the sound gate to see if the sound were affected. If it were, the guide rollers should be adjusted.
3. Tighten the exciting lamp adjustment and listen for change in hum when pressure is applied to the exciting lamp holder in order to reduce vibration.
4. Check for stray light leaking into the photocell (a.c. light).
5. Connect the headphones to the output of the projector amplifier or transformer. If hum is present, then the cause is exciting lamp assembly, vibration, sagging filament, breakdown of filter units supplying either the photocell, the exciting lamps, or the machine amplifier if any, or else faulty suspension of the machine amplifier. Some machine vibration is high enough to be heard in the high-frequency horns, but not in all cases, especially when the cross-over frequency is 400 cycles or higher.
6. If no hum on test 5, connect the headphones to the input of the voltage amplifier. No hum here indicates that the trouble is within the voltage amplifier. If replacing the tubes does not help, there is something radically wrong within the amplifier, such as the rectifier filter inductance shorted, or an open-circuited filter condenser.

If the hum were being heard on both machines, I would make test 1 and then test 6. If hum were heard on test 6, then I would go to 5. In this case vibration would be an unlikely cause, as would sagging filaments or stray a.c. light to the photocell. The trouble would more than likely be due to filter troubles in the power supplies mentioned in test 5.

It is assumed, of course, that the hum is not in the recording, a factor which must always be considered. We had a print from a major studio (a "big" picture, too) in which two successive reels evidenced a distinct hum.

B. If no hum is heard on raising the monitor volume, then the source is beyond this point, and I would:

1. Check the tubes in the low-frequency amplifiers, paying particular attention to the rectifier tubes.
2. If the speaker power supply was in the projection room, and it was possible to change tubes during operation I would do so—that is, if the unit had rectifying tubes. Since the high-frequency horns have a limited mouth area, they would not be putting out hum which would be heard, because the low-frequency horns would be so much louder—that is, the cut-off frequency of the high-frequency horns, exclusive of the dividing filter network, is rather high and any a.c. hum would be appreciably attenuated.
3. If trouble is not cleared on tests 1

and 2, or if 2 were impossible because of the location, *etc.*, I would connect the headset to the output of the low-frequency amplifier. If hum were heard, then the trouble would be within that amplifier—either unbalanced rectifier tubes, or defective filter, such as open condenser circuit or shorted inductance, or some other radical defect.

4. If no hum were heard on 3, then the speaker supply unit is faulty, and either the filter circuit or the rectifier is to blame. If the former case a wire to a condenser is broken or an inductance is shorted. If the latter, there is either an unbalanced condition of the rectifying tubes, or one of the stacks of a contact rectifier is out of adjustment, as the case might be.

When it is said that there may be an unbalanced condition of the rectifier tubes (full-wave pair) or amplifier tubes (push-pull), this is also meant to include the extreme condition of a burned out tube.

20. Sound is weak in the high-frequency speaker. What procedure would you follow to restore normal quality and volume with the least possible delay?

By THEODORE P. HOVER

Once again we check by the monitor speaker. If normal high-frequencies are present from this speaker, the trouble must be with the filter network, high-frequency amplifier, or speaker. If the high-frequencies are absent from the monitor speaker, the trouble can be anywhere in the voltage amplifier back to the sound heads, in which case optical systems and sound track alignment would be the first to receive attention and a voltage amplifier test would be next.

If the monitor signals are o.k., the high-frequency speaker field supply would probably be the next most likely source, and a check should be made for an open field or a loose connection. Since the low-frequency speakers are o.k., the field current source cannot be blamed. If the speaker field is o.k., the high-frequency amplifier should next receive attention, all tubes being checked.

If this does not reveal the trouble, a close check should be made in the filter network or volume control of the high-frequency speaker for defective units or loose connections.

Those contestants who submitted papers averaging fifty per cent correct or better were:

E. Renfroe, Chicago, Ill.; S. E. Mervine, Pottsville, Penna.; Roy J. Arnston, Minneapolis, Minn.; Ray Mowery, Mahonoy City, Penna.; Haynes Howell, Tucumcari, New Mex.; J. T. Kirkham, Calgary, Canada; Bill Franke, Boston, Mass.; Don Howard, Rawlins, Wyo.; Chester A. Ellison, Reading, Mass.; W. Fenwick, Victoria, Canada.

Also, T. Morisawa, Los Angeles, Calif.; Gerald H. Payne, Westerly, R. I.; Walter Fink, Mahonoy City, Penna.; Earl H. Griffen, Hillsboro, N. H.; R. A. Young, Homstead, Fla.; Carl Rossi, Brooklyn, N. Y.; Frank Swalbert, Buffalo, N. Y.; Walter R. Pyle, Assinboia, Canada; Leo Ciminkoski, Norwich, Conn., and John L. Stauffer, Steubenville, Ohio.

TAKE-UP TROUBLES: HOW TO LOCATE AND CORRECT THEM

(*Continued from page 8*)

distance equal to the thickness of the washers. It is then unnecessary to re-splice the belt, and does away with the guesswork in estimating the proper length to cut off.

A necessary precaution is to see that the washers are the same thickness, and that the surfaces of each washer are parallel. Any shortcoming here may strain or break the casting.

Some projectors are equipped with a spring-loaded idler pulley which keeps the belt at the proper tension and eliminates the need for cutting the belt. We contemplate putting idlers on our outfit, but instead of using a spring we will probably have the idler on a bracket so pivoted that a weight supplies the tension.

In devising an idler the design should be such that the idler rides on the slack side of the belt, that part of the belt which runs down, unless some condition prevents this construction. It requires less pressure on the slack side than it does on the tight side. It should also be placed closest to the small pulley, and on the outside of the belt. In this way it causes the belt to wrap around the small pulley to a greater extent, thus giving more friction right where it is needed most.

In our case it will be advisable to place the idler on the tight side of the belt, because it will then make the belt run a bit farther away from some of the terminals and the shielding in the sound head.

(TO BE CONTINUED)

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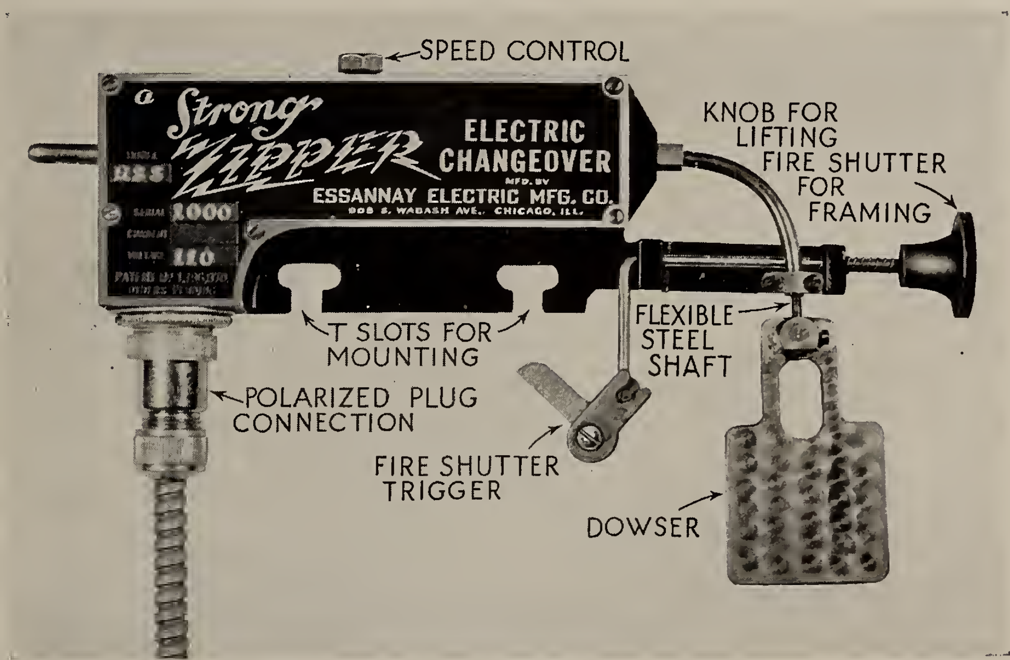

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Irving Dashkin, Mgr.

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JULY 1938

VOLUME 13 • NUMBER 7

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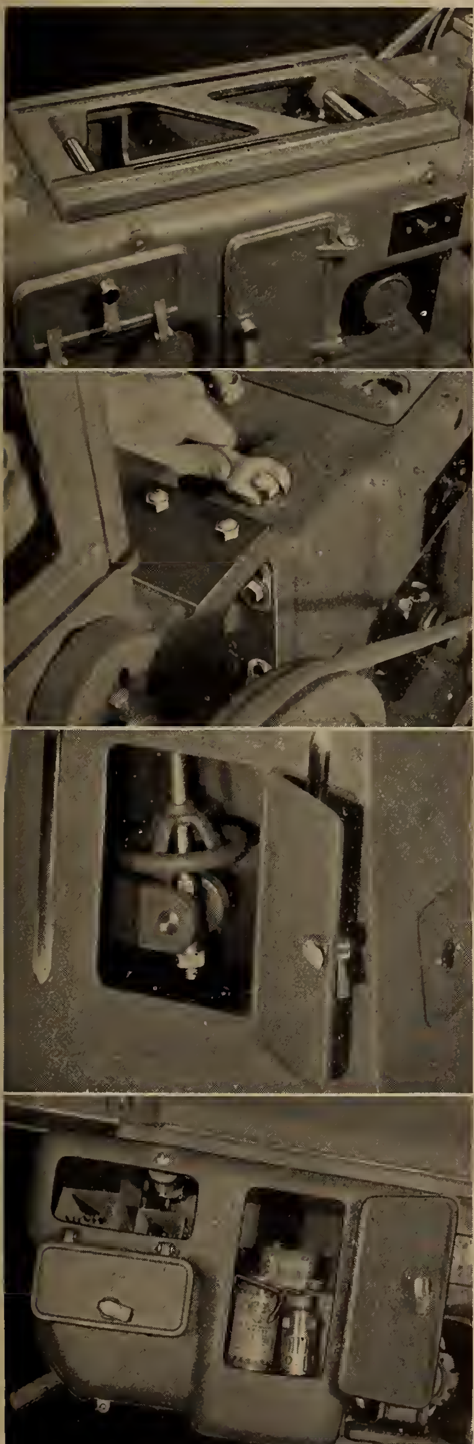

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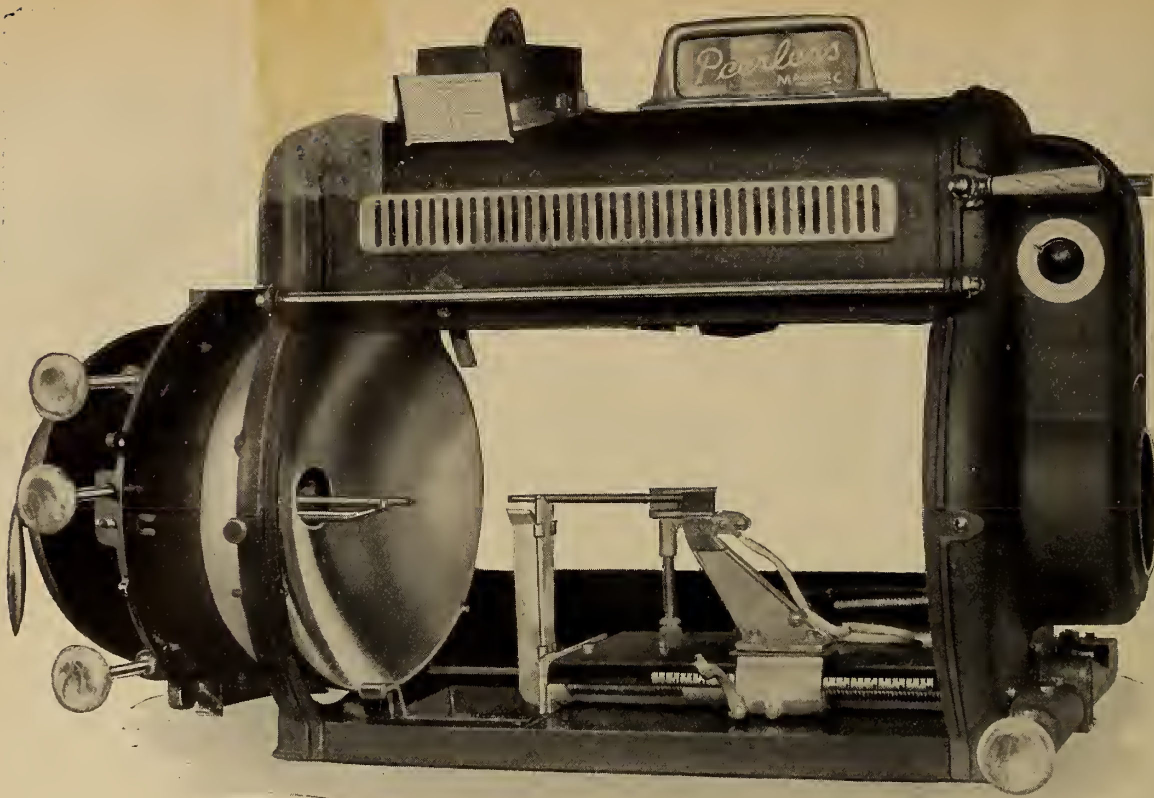

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Edited by James J. Finn

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MONTHLY CHAT

NOT much in the way of graphs, tables or math herein this month, such brown-creasing stuff having given 'way to material which, while not requiring extreme cerebral activity, is weighted down with fact and fancy that should prove both interesting and useful to the man in the projection room.

Repercussions of the recent I. A. convention in Cleveland continue to be felt in this office. As we said, this was the all-time, all-high, all champ I. A. gathering—so good, in fact, that all Locals who formerly harbored thoughts of being host to the next convention now can barely be seen disappearing over the horizon.

Elsewhere herein is cited the use by British projectionists of mirrors split down the middle to "allow for expansion" of the glass. Which reminds us of one "depression" night when the manager of Detroit's beautiful Fisher Theatre frantically phoned upstairs to say that the cue called for a flood. One of the boys answered: "You have it"; and he did, but nobody knew it because the condenser, like some optical people, was cracked, criss-cross fashion.

THOSE who entertain the notion that a projection room is just a place where the "operator" hangs his coat between meals (as who doesn't in this business?) are invited to visit I. P.'s office and inspect the answers accumulated from projectionists during the Question and Answer Contest now concluded in these pages. There isn't a service engineer in the industry who could top, if match, a batch of answers turned in by some of these "dumb operators."

We're proud to have readers like those who participated in the Contest—and a little scared, for ourselves and for the craft. Unquestionably there is a wide cleavage in ability among the craft: one group is 'way out front and going strong; another group is standing still, if not retrogressing. This makes our task all the more difficult, because we must serve both groups. What is the proper editorial level? We know the answer on both sides of the fence; but these are just answers, not a solution to the problem. Split the magazine into sections? That's out!

We can't keep the progressives in kindergarten; nor can we long hold readers who are away in deep over their heads. Maybe there exists somewhere someone who knows the answer to this riddle, and if so, we beg of him his kind indulgence.

JUST a penny postcard bearing your old and new address is needed to insure regular receipt of your I. P. You'll like this, and we'll appreciate it. Thanks.

INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 7

JULY 1938

Some Common Sources of Noise in Theatre Sound Systems

II.

By *AARON NADELL*

NOISE, like hum, becomes a more serious trouble with increasing improvement in sound equipment. Modern frequency ranges make audible noise components that previously could not be heard. Modern squeeze tracks with their ultra-low background level (see I. P. for June, p. 22) also add prominence to noises originating in the sound equipment. The illusion of reality produced by the tonal perfection of present-day recording and reproduction adds to the undesirability of extraneous disturbances.

Noise differs from hum in that the latter possesses some definite frequency or tone; with noise, while some one pitch may and often does predominate, the essential characteristic of the disturbance is a complex sound composed of many frequencies that do not stand in harmonic relation to each other. Further, a hum, which has a single, definite cause, is much more likely to be constant, while many noises are intermittent in nature and correspondingly difficult to run down.

A common type of noise, and one of the easiest to diagnose, is the disturbance picked up from the projector head. In modern systems, which do not mount amplifiers on the projector assembly, the possible causes of this particular trouble are reduced to a minimum and trouble-shooting is simplified accordingly.

Among the characteristics of projector noise which aid tracing is the fact that it invariably seems louder in the stage speakers than in the monitor. Often, in fact, it is not heard in the monitor at all, and the projection staff never know the trouble exists until the management complains. The reason is that a microphonic pick-up of projector noise may sound exactly like the projector itself. When noise is heard in the stage speakers only, or is much louder in the stage speakers than in the monitor, and when it bears any resemblance to one or all of the component sounds produced by the projector in action, microphonic pick-up is always to be suspected; the next change-over will most likely confirm the diagnosis with complete finality.

Finally, microphonic pick-up of projector vibration, unlike some types of noise discussed subsequently is usually continuous rather than intermittent, further simplifying the work of finding it.

● Crackling, Rasping Noise

Disturbances in this category are exceedingly difficult to run down. The general cause is always the same: a conducting path of changeable resistance resulting in an irregular flow of current. Sparking, visible or microscopic, is often present. But the imperfect contact may be located almost anywhere in the sound system and in many circuits that have no direct connection with sound at all. It may be a series contact, through which current is intended to flow, or an irregular, high-resistance short-circuit.

Worst of all, this form of trouble is very likely to disappear of itself, and to return again unexpectedly. This de-

ceptive behavior often leads the inexperienced trouble-shooter to think that his last effort achieved a cure. Disappointment and exasperation follow, perhaps days later.

One common cause is a defective resistor, especially of the so-called carbon type. These units often consist of very fine carbon particles dispersed in a high-resistance cement. They are made in values up to ten million ohms. Carbon itself has no such insulating properties: the carbon granules in a microphone, for example, offer only two hundred ohms resistance—sometimes less. In high-ohmage resistors the carbon particles are relatively far apart, separated by the cementing medium. This cement tends to dry out unless the resistor is of truly* high quality, and sometimes even then. As part of the material evaporates, its place is taken by microscopic cracks across which minute sparking occurs, which is practically always internal and invisible. The resistor then becomes "noisy."

The condition is often varied by temperature, humidity and changes in the applied voltage. A useful clue in trouble-shooting is to remember that the high-resistance units (those rated in hundreds of thousands or millions of ohms) are more likely to become noisy than carbon resistors of lower rating. Another is to note that overheating, caused by even a momentary strong overload, has a marked tendency to produce resistor noise by baking out the more volatile portions of the cement. A unit that has been subjected to overload should be the first suspect.

Wire-wound resistors become noisy through overload or inherent defect that melts the wire. A common occurrence is failure of the circuit to open completely, inasmuch as the wire is buried in enamel and the molten metal has no path of escape. It may not make perfect contact, however, when it resolidifies. This condition usually appears at the point where contact leads are attached. Wire-wound resistors commonly are of comparatively small resistance —a few thousand ohms at most—and carry appreciable currents which may cause them to heat in operation. If one portion of the enamel is distinctly hotter than the rest, internal sparking is strongly indicated.

● Sliding Contacts

Potentiometers, especially those used as volume and tone controls, are made both in wire-wound and carbon types. Usually the wire is exposed and will break away, opening the circuit entirely, if imperfect contact occurs at any point. Some, however, are enamelled with just enough of the enamel scraped away to permit the slider to touch the wire. These are subject to the same trouble possibilities as any other enamelled resistor. The carbon type use a disc, plate or tape of carbonized material: in these the volatile components of the binder sometimes evaporate as in any other carbon resistor, and with the same results.

However, in potentiometers and rheostats the sliding contact is the most probable cause of noise. This may be due to warping or shrinkage of a carbon disc or plate, or to warping or shrinkage of the insulating material on which the resistance wire is wound. In both cases, replacement is the only safe remedy. If the sliding contact has merely lost its tension, bending it may effect a cure. The trouble may not lie between the slider and the resisting material, but between the slider and the external circuit.

Condensers, both of the electrolytic and the paper (or mica) types, also become noisy. The electrolytic form is subject to drying out, with consequent deterioration of the chemically-formed insulating layer. The latest metal-sealed electrolytics are most reliable in this respect, and should be preferred for replacements. In the paper type, excessive voltage may produce a slight puncture which is temporarily healed by a flow of the heated oil or paraffine with which the paper is impregnated. The result is a small area in the insulation that consists not of paper plus paraffine but of the re-solidified paraffine alone. In this area the insulation may break down and restore itself repeatedly, producing noise. A pin-hole puncture in a mica condenser behaves somewhat in the same way, in that the pin-hole is the place where sparking will occur during voltage peaks.

This type of trouble is most common in condensers that carry only speech current, where the applied voltage is irregular, and there are many intervals of reduced strain during which sparking stops and healing may take place. Where the condenser is so located that a momentary flashover is likely to be followed by a steady flow through the puncture of fairly strong current, development of a noisy condition is far less probable than is a complete breakdown.

Thus in Fig. 1, the condenser most likely to become noisy is the .01-mfd. coupling unit at the top of the drawing. It is protected on both sides by resistors of high value that will prevent very strong d.c. flowing through a momentary puncture and making the condition worse. The .01 grid bias resistor by-pass condensers may grow noisy, but are somewhat more likely to break down entirely. The other three condensers in the drawing (if of the paper type) should be suspected of noise only as a last resort: in all probability the first slight sparking one of them develops will be followed by a surge of B current strong enough to burn out the unit entirely.

Switches, especially of the jack or key type, are a fruitful source of imperfect contacts that lead to noise. Where dirt is responsible, the remedy is obvious, but where the prongs have lost their tension or been bent out of shape (perhaps by mishandling) permanent repairs are often difficult, and replacement may prove to be the only reliable remedy.

Fuses, including power line fuses usually not thought of as sources of sound trouble, frequently cause noise by reason of imperfect contact with the fuse metal. General fuse replacement is one remedy resorted to in the most obstinate cases of noise. Other opportunities for poor contact exist, of course, in any soldered connection whatever; noise elimination overhaul often includes a night's work at resoldering almost all the contacts in the system.

In the case of inductive windings, most choke coils can be disregarded as possible sources of noise, for the same reason that the larger condensers in Fig. 1 are disregarded. They are almost always exposed to a substantial flow of current that will break them down completely rather than permit continued

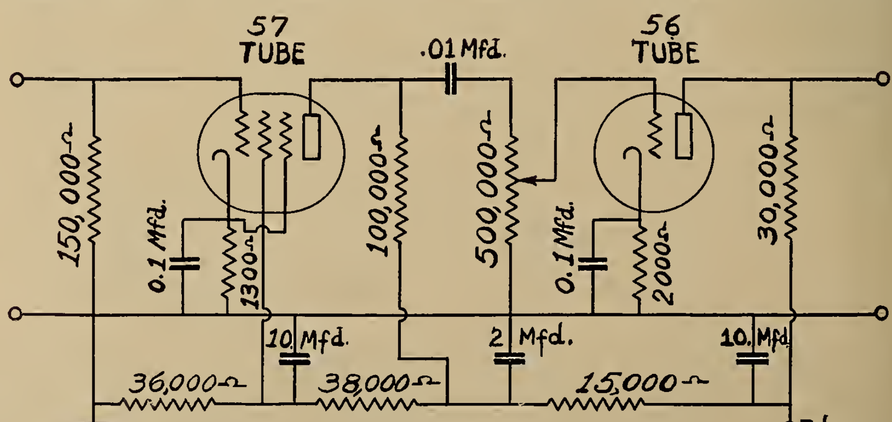


FIGURE 1

inefficient operation. The same is not true, however, of transformers that carry speech current only, which can readily become noisy. Complete replacement can often be avoided: in many cases the bad connection will be found, or associated with, the external terminal board of the winding.

● Tube, Socket Troubles

Noisy tubes are commonplace: the cause may be imperfect welding of the internal units or faulty soldering at the base prong or grid prong. In the latter case, the tube can usually be repaired, if it is of a size and cost to justify the trouble, which most of the more modern tubes are not. There still are many sound systems that utilize expensive tubes, costing more than ten dollars per unit; but the majority of present-day equipments are designed for the two-dollar tube, even in the output stage.

Sockets also are less likely to set up noise. The older type, with flat contact leaves pressing upward against the bottom of the tube prong, still need watching and cleaning; the newer kind, in which the contact clips embrace the sides of the tube prong, are more reliable and need not be suspected until more probable causes have been thoroughly examined.

Ground connections still can be as troublesome as ever, especially water-pipe grounds, which are subject to loosening and corrosion. Ground contact noise is one that may seem to originate at every point in the system, and should be suspected when locating the point of noise origin proves exceptionally difficult.

The defective contact, as stated, may be outside the sound system entirely: thus sparking at the arc feed motor relay points is a familiar source of noise which can be picked up by the sound equipment. The remedy in this case may involve external units, such as cleaning and adjusting the relay contacts, or bridging them with a condenser to reduce sparking; or it may involve investigation of the sound head shielding and grounding, or all these steps.

All the imperfect contacts mentioned thus far, both in apparatus and in wiring, are series contacts. Exactly similar symptoms are produced by an intermittent short-circuit or ground. A well-known type of short of this character occurs in lead-shielded cable when the sheath has not been carefully stripped. A jagged edge piercing the underlying rubber insulation produces an intermittently noisy ground connection.

Coaxial cable, as used for modern photo-cell connections, picks up projector oil, which accumulates in the insulation and eventually causes noise. The only remedy is replacement.

Causes of this form of trouble are so numerous (as has been seen) and symptoms so uniform regardless of cause, that general rules for finding it are quite useless. Some hints may have value.

Thus, in the case of Fig. 1 it has been noted that the .01-mfd. coupling condenser is more likely to be at fault in this way than any of the other condensers. Similarly the 500,000-ohm potentiometer should be the first resistor investigated. It carries no appreciable current—none strong enough to break down a small flaw and make the unit entirely inoperative. Moreover, it embodies a moveable contact, always a possible source of noise. The same considerations, except for the moveable contact, indicate the 150,000-ohm resistor at the extreme left as the next most likely suspect.

Headphone tests are useful only occasionally. Thus, if the left-hand 150,000-ohm unit in Fig. 1 were at fault, noise might very possibly *not* be heard there (owing to its low level) and still be heard almost everywhere else in the unit diagrammed. Or noise originating in the 15,000-ohm voltage divider unit would be heard throughout Fig. 1; and the same might be true of an imperfect ground connection at "A."

When, as often happens, the trouble is intermittent, headphone tests become still more difficult and more exasperating. One of the best remedies is to wait until the show breaks and then overload, shock, shake, pull, rattle and tear through all suspicious components or wiring until the merely imperfect contact is broken down to a thorough open (or thorough short, as the case may be)—a condition that can readily be reached through ordinary trouble-shooting.

Headphone and battery tests of the components—disconnected from the normal circuit for that purpose—are useful only if the test battery voltage is equal to that under which the component normally operates. A resistor or condenser noisy at 200 volts may be silent at 90.

A remedy of desperation, after soldered contacts have been gone over and all ordinary remedies have been exhausted, is wholesale replacement. Thus, if noise is known with certainty to exist in Fig. 1 but is difficult to find, every resistor and condenser in that unit can be replaced, at present prices, at a cost of about two dollars for materials alone. Amplifier replacement parts were far more expensive a few years ago, thus this method of quick treatment never gained much favor. Under modern conditions it is worth consideration, as a somewhat sloppy procedure and not to be recommended as good engineering practice, yet preferable to allowing an obstinate noise to disturb the audience for days or weeks at a time.

● Various Popping Noises

A different type of noise having a somewhat similar cause is a pop-gun sound, which may appear in volleys or only occasionally as a single discharge. The latter resembles somewhat the sound of an imperfect patch passing through the exciting light; the former, a quick succession of such patches.

Where patches and similar film faults may be eliminated as causes, the condition is almost invariably due to a sudden rush of current through a reasonably good but highly temporary connection. The symptom is not only trouble in itself but quite often a warning of impending breakdown, thus requiring unusually prompt attention.

This form of trouble, if it constitutes a surge of material dimensions, can often be discovered by watching meter fluctuations either in the power supply line meters normally installed or in analyzer instruments temporarily connected for the purpose. The plate current meter, however, is an unreliable indicator in this case, since it may respond with a slight flicker to the change in sound current representative of the noise rather than of the basic cause. Headphone tests and elimination *via* block schematic are more useful in this case than with other noises.

● Special Precautions

When a noise of any description is highly irregular in its appearance and (however annoying) does not persist for long, special steps out of the line of ordinary trouble-shooting are likely to be essential. Consider a noise more or less continuously present, and assume that Test No. 1 has failed to show

(*Continued, Col. 1, page 13*)

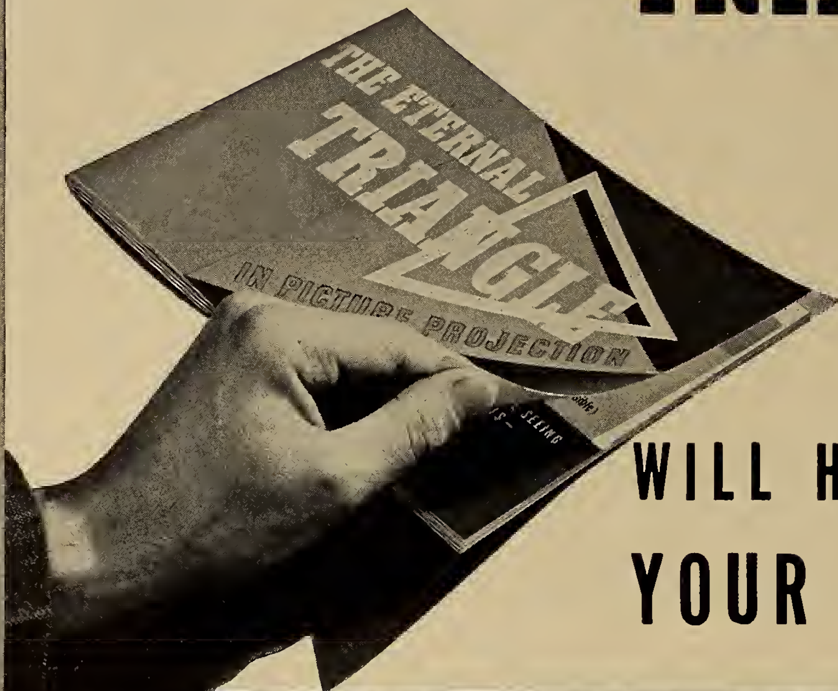
ERRATUM

'Variable Area' is Academy Standard Nomenclature for Sound Track

In the June issue of I. P., the article by John K. Hilliard entitled "Academy R. C. Nomenclature for Release Print Sound-Tracks," beginning on page 22:

In reprinting this article, an official release by the Academy of Motion Picture Arts and Sciences, I. P. substituted throughout, including illustration captions, the term "variable width" for the term "variable area". The Academy urgently requests that emphatic notice be given of its recognition of the term "variable area" as standard nomenclature.

A STUDY OF THE TRIANGLE



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The S. M. P. E. Projection Practice Committee Holds a Meeting—Ha!

(IMPORTANT NOTE: I. P. assumes no responsibility for any consequences arising from a reading of this alleged article.)

OCCASIONALLY the Projection Practice Committee of the S.M.P.E. at its meetings goes to profound depths in its cinematographic brain waves, and once in a while these efforts take the form of scintillations that one might attempt to regard as more psychologic than cinematic. However, after spending hours upon such grimly sober problems as theatre characteristics, dimensions of projector apertures, and fire prevention in projection rooms, perhaps the Committee is entitled to a little emotional relief during a long meeting on a hot damp evening by asking such questions as how large a screen would be required if all the picture images on a feature film were cut out and glued in rows upon the screen surface. Guesses as to the answer varied from square feet to square miles.

Dr. Goldsmith, the Committee's official encyclopedia, raised the question, and forthwith proceeded to supply the answer without the aid of calculating machines or logarithmic tables; and, strange to say, by a weird process of "free-hand thinking," produced the answer almost without aid of pencil and paper; namely, that for the average feature-length picture, *the integrated or total area of all the picture images on the film is very approximately equal to the superficial area of the screen.*

If anyone does not believe that startling statement to be true, he is invited to try his own paper and pencil. The arithmetic is very simple: merely multiply the width and height of the film image (namely, 0.600 by 0.825 inch) by the number of frames per foot (16) by the number of feet in the average feature film (6,600 feet). The result of the calculation will show that there are 363 square feet of image on the film.

● The Inmates Escape

Now suppose we have in our theatre, in which this feature picture is being projected, a screen that has been marked to the dimensions 22 by 16.5 feet. The area of this screen is then exactly 363 square feet, which was the same as the total or integrated area of the picture images on the film, thus verifying our thesis that "Feature Films Are No Bigger Than the Show," or *vice versa.*

Of course, one has to recognize the fact that this proposition holds *exactly* only when the correct combination of length of film and size of screen are chosen. However, it is a very practical fact to bear in mind, as applying to the average length of feature pictures. The screen size chosen above, however, may be slightly larger than the average theatre screen: for example, if the screen were 15 by 20, the area of the screen would equal the integrated area of the picture images on a film 5,450 feet long.

At this point of the discussion, which, by the way, took place at the latest meeting of the Committee, enthusiasm about the idea became almost rampant. Someone wanted to know whether it would be possible, in some very simple manner, to relate magnification to the length of a feature film or to some similar factor.

Another calculation by Dr. Goldsmith worked out as follows: Dividing the area of the screen (22 by 16.5 ft.) by the inch area of the image on the film (0.600 by 0.825 inch) we get the area magnification, namely 105,500. Now, if we multiply the number of frames per foot by the length of our average feature film, which we have taken as 6,600 feet, we also get 105,500. The conclusion, therefore, is that for our average feature-length film, the *area magnification is approximately* (in this assumed case exactly) *equal to the number of frames in the film.*

Interest in the fantasy now became a frenzy. Someone wanted to know whether it would not be possible to enlarge the picture images on the film to screen size, somewhat as we do nowadays for mural decorations. The countryside is badly disfigured by all sorts of billboards and other advertising display, and it might be a relief if all the picture images on a feature film were set up seriatim in large size along the highways of the nation, so that motorists could really enjoy movies during their cross-country trips and not be bored by the natural beauties along the way.

Of course, it would probably be necessary to affix to the motorist's eyes a pair of horseblinkers, and these blinkers would probably have to flap up and down at the rate of 24 times a second. A little inconvenience might result therefrom, but the Committee feels certain that the observers would not be seriously discommoded by heating at the gate or warping of the film.

● Lunacy Board Note

Reproduced at screen-size, the pictures would be 22 feet long, as we have assumed throughout this erudite discussion. Twenty-four such pictures would have to be passed during each second. Analyzing this further by Fourier's series and Bessel's functions, and taking into consideration all the intricacies of the Brownian movement, it speedily follows that the motorist would have to travel upon a super-deluxe six-lane highway at a speed of 450 miles an hour, to see a good full-size movie without flicker—which is not very unreasonable in these days of super-streamline travel.

By throwing a spot-light on the sound-track, suitably magnified and running parallel to the road, and picking up the reflected light on a telephoto cell, excellent sound will be heard by the motorist.

In closing, the Committee feels that it has made, in this discussion, a major contribution to the progress of the cinematographic art.

[NOTE: *at this point the keepers arrived.*]

COMMON SOURCES OF NOISE IN THEATRE SOUND SYSTEMS

(*Continued from page* 11)

its cause. The trouble-shooter then proceeds to Test No. 2; but with an erratic noise the trouble may disappear again before Test No. 2 can be applied, and may not return for hours or, perhaps, days. It is consequently necessary to prepare in advance for the quickest possible application, when the trouble does reappear, not only of Test No. 2 but also of Nos. 3, 4 and 5. This may involve permanent connection of meters and headphones, perhaps of special switching facilities, for the duration of the difficulty.

For example, suppose that the unit shown in Fig. 1 develops a popping noise accompanied by temporary lowering of volume. Suppose that there exists a suspicion of a momentary grounding of the negative side of the 38,000-ohm divider resistor, but also a chance of momentary grounding of the heater circuit, which is not shown in the drawing. If a d.c. voltmeter be connected from the negative side of 38,000 ohms to the ground, and headphones wired to the heater circuit, both possibilities can be checked simultaneously.

But the B power supply may also be under suspicion, and the performance, if any, of the d.c. voltmeter just mentioned can be double-checked against that possibility by a second meter, or a neon tester, from the B plus terminal to the ground. The next appearance of the trouble, if it lasts long enough to allow only a momentary check of the meter needles and headphone noise, will either indicate the cause or eliminate three possibilities in one step.

The specifications and recommendations contained in this report have been prepared for the guidance of the engineering departments of the producing companies participating in the Academy Research Council cooperative technical program, and the engineering departments of the associated companies affiliated with these producing companies, in purchasing new sound projection equipment. Copies of the report have been distributed through each company's representative on the Council to the proper officials in each company.

Copies of the report are also available upon request to all sound equipment manufacturers, to be used as a guide in designing, testing, or manufacturing new equipment, or to theatre servicing organizations and exhibitors who may be interested in the opinions of the Council on sound reproducing equipment.

The entire aim of the Council and the Committee is to prepare standards and specifications for theatre sound equipment which will permit the best possible reproduction, under general operating conditions, of the recorded product of all studios in all theatres, regardless of the type or manufacture of the sound reproducing equipment.

As part of the program, the Committee installed several complete reproducing equipments in one theatre and conducted an extended series of experimental tests on each of these equipments under identical operating conditions.

Academy Recommendations on Theatre Sound Reproducing Equipment

PREPARED BY THE RESEARCH COUNCIL COMMITTEE ON STANDARDIZATION

IT HAS been found in general that the present two-way speaker systems as currently manufactured, consisting of a true multi-cellular, high-frequency horn and a dynamic low-frequency unit with a substantial air column, give a considerable improvement in reproduced sound quality over that secured in the past. However, certain differences exist between the present systems which make it difficult for the recording studios to accurately determine the average characteristic of theatre reproducing systems.

While these differences may not seem to the casual observer to be of great magnitude, it is felt that the existing differences in studio product cannot be materially reduced until such time as the loud-speakers appear more acoustically alike to the trained observer.

The following information has been compiled in an effort to help to produce this result. This report, containing the following general specifications, has been divided for convenience into six parts:

Part 1—Sound Head and Associated Equipment.

Part 2—Volume Control Equipment.

Part 3—Amplifiers and Filters.

Part 4—Loud-Speakers and Dividing Networks.

Part 5—Servicing Requirements.

Part 6—Studio and Preview Theatre Requirements.

Part I—Sound Head and Associated Equipment

Noise Level: The sound head shall be so designed that the noise level due to vibration of gear and drive equipment will be sufficiently low that the overall system, of which this sound head is a part, will meet the —35 db/.006 watts hum level as described in a later specification.

Combining the photocell and optical system on a single vibration-proof mounting plate, mounting the drive motors in a shockproof assembly, the use of adequate shielding of the photocell transformer and other electrical equipment in the sound head and the use of a static shield to reduce static pickup by the film and drum are examples of good design practice to minimize hum and electrical noises in the sound head.

Sprocket hole noise caused by scattered light which results in 96-cycle modulation has been minimized either by the use of a mask to block out the scanning beam between the sound track and sprocket holes, or by designing an optical system which reduces the light leakage.

Uniformity of Output Volume: The illumination in a lateral direction across the scanning slit shall be such that the maximum variation in the output of the photocell will be less than ±1½ db when measured with a track consisting of non-overlapping increments, each of not more than 7 mils width.

Regulation equipment shall be available so that when the power line voltage changes ten per cent, the overall gain of the system, including the exciter lamp, photocell, amplifiers, and horn fields, shall not vary more than 2 db as measured in terms of the acoustical output from the speakers.

Weave: The weave in the sound head shall not be greater than ±2 mils. The Committee has often observed sprocket hole and other noises due to weave in reproduction from both variable area and variable density recordings, and a

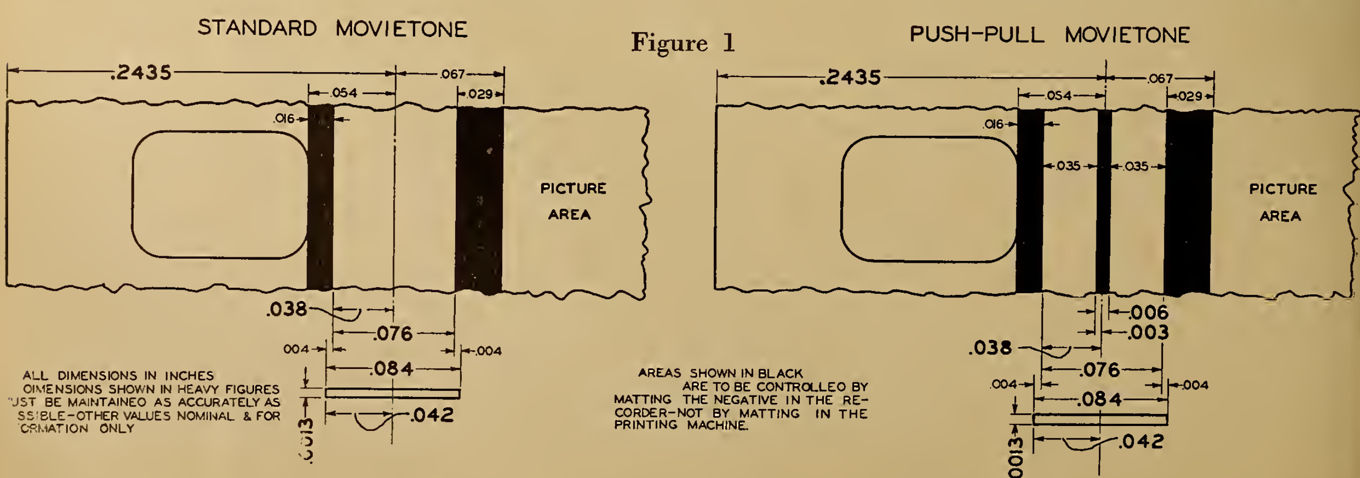


Figure 1

clipping of peaks in the case of variable area.

Film Damage: The design of the head shall be such as to avoid all possibility of damage to the film, in both picture and sound track areas. At no point in the travel of the film through the picture and sound heads should the sound track area, either emulsion or celluloid side, come into contact with any part of the equipment. All idler rollers should turn freely and the shoulders on both sides of all rollers and sprockets should be relieved.

The rollers and sprockets of the projection head and the rollers of the fire trap should also be relieved in the sound-track area. Consideration should be given to the possibility of guiding the film through the first trap to avoid scratching the film.

Oil Leakage: In the design of the sound head, consideration should be given to the location of the electrical and optical equipment so as to minimize difficulties due to oil leakage from sound and picture heads. The use of oil-proof wiring throughout the sound head has been found to be very desirable.

Push-Pull Cancellation: The design shall include provision for an easy method of obtaining a maximum push-pull cancellation. The balance should be extended as far as possible over the entire frequency range from 50 to 8,000 cycles, with a minimum cancellation of 25 db below 1,000 c.p.s.

Track Location: The track location and scanning width shall be set according to the Proposed Standard Sound Track Dimensions and Position (Fig. 1). It will be noted that all matting will be done in the negative and that no septum is required in the sound head for the reproduction of push-pull recording.

Starting Speed: Flywheels or an equivalent device shall be used to limit starting acceleration.

Flutter: The total flutter shall be less than 0.15 of 1%, as measured with the Erpi Flutter Measuring Instrument; or less than 0.30 of 1% as measured with the RCA Flutter Measuring Instrument. (Standardization of flutter measurement procedure is now under consideration by the Research Council, upon which a supplementary report will be issued within the near future.)

Part II—Volume Control Equipment

Volume Control Range: Adjustable gain control of at least 50 db in 2 db steps shall be provided, of which at least 16 db is available at the changeover position on the wall. The wall attenuator is required at the changeover position, because of the great difference in level between news reels and Hi-Range prints[1]. The additional volume control shall be a detent operated device incorporated in the main amplifier to be used to compensate for any abnormal conditions which may arise.

Machine Balance: Balancing facilities shall be provided to allow the output of each machine to be balanced to within 1 db.

Part III—Amplifiers and Filters

Gain: The overall gain of the system shall be sufficient to provide 20 db in excess of normal requirement.

Frequency Response: The complete electrical system shall be capable of a frequency response varying not more than ±1 db in the range from 40 to 10,000 c.p.s.

Distortion: At its rated output the amplifier shall not generate more than 2% total harmonic in the frequency range from 50 to 5,000 c.p.s. Amplifier output is the average power into the specified resistance load when the amplifier is excited with sinusoidal input signal. The harmonic content is defined in terms of a ratio of currents between the root mean square sum of all harmonic components and the fundamental.

The Low-Pass Filter: The low-pass filter shall be designed to obtain the Standard Electrical Characteristic as specified by the Research Council.

It is anticipated that changes in the electrical characteristic will be necessary from time to time, and for this reason the low-pass filter shall be adjustable over a wide range. The low-pass filter shall be inserted in a position in the circuit such that it is not subject to extraneous pickup and will be capable of filtering out hiss and high-frequency disturbances generated in the early stages of the amplifier.

Hum Level: Under operating conditions the residual hum due to frequencies below approximately 300 c.p.s. shall not be greater than —35 db/0.006 watts and the high-frequency noises shall be sufficiently below this value so that the machine, running without film, will have an output noise which is principally hum and is no greater than —35 db.

This specification has been so set up that no hum will be audible in the front row seats in the theatre auditorium under normal operating conditions.

Part IV — Loud-Speakers and Dividing Networks

Acoustic Response: As measured with a flat overall electrical characteristic, the trend of the acoustic response of the loud-speaker system when measured by the conventional warble frequency method shall not vary by more than ±3 db from the following characteristic: namely, flat over the frequency range from 50 to 2,000 cycles; not decreasing more than 5 db per octave in the range from 2,000 to 10,000 cycles; and not decreasing more than 10 db from 50 to 30 cycles.

The loud-speaker system shall be designed to adequately carry the rated output of the amplifier system.

The conventional method of measurement aforementioned involves the averaging of five (5) or more readings made with the microphone close to the speakers. In making these measurements, care must be taken to select microphone positions which will not favor the response of either the high- or low-frequency units. The most suitable conditions under which such measurements can be made are either in a large acoustically dead room or out of doors. In either case the intensity of extraneous noises must be sufficiently low not to affect the measurements.

Electro-Acoustical Efficiency: A magnetic structure shall be provided which is as efficient and distortionless as present deluxe two-way horn systems, to avoid the necessity of increasing the power-handling capacity of the amplifiers.

Angular Distribution: In certain installations it is necessary to have a wide horizontal coverage, and a high-frequency horn shall be available which will cover a maximum horizontal angle of 105°. Horns shall also be available

(*Continued on page* 29)

TABLE A

S.M.P.E. Projection Committee Theatre Survey: Characteristics of Theatres

	Lower Extreme	50% of the Theatres Min.	Av.	Max.	Upper Extreme
Ratio max. viewing dist. to screen width	2.60	4.65	5.20	5.85	8.00
Ratio seating length to seating width	0.90	1.52	1.98	2.35	3.50
Ratio rear seating width to screen width	1.00	2.50	3.00	3.50	6.20
Screen width	10′	16′	18′-6″	21′	34′
Distance from floor to bottom of screen	3′-0″	4′-9″	5′-4″	5′-9″	8′-2″
Projection angle	0°	5°	10°.5	15°	35°
Amperes (arc) per sq. ft. of screen surface	0.06	0.16	0.20	0.24	0.44

[1]See I. P. for Jan., 1938, p. 24.

Show Business in England: Craft and Technical Aspects

By *ERIC WILLIAMS*

MEMBER, LOCAL UNION 348, VANCOUVER, B. C., CANADA

Here are some of the many interesting things we heard from the author upon his return from England after a prolonged stay. The first commitment of this story to the printed page was in the *Quarterly Bulletin* of I. A. District No. 1, to which we are indebted for the right to reprint.

THERE isn't a city in the world that provides such a variety and quantity of entertainment for the public as London. The following list will give some idea of the amusements provided at the beginning of 1938:

First, there were fifty odd legitimate theatres running, several with two shows, one for the matinees and one for the evenings; next, ten or eleven straight vaudeville houses with two shows a night; one theatre with opera and ballet; two non-stop reviews running from 2 to 11:30 p. m. I don't know how many "cinemas" there are, but more than one hundred of the largest advertise in the daily papers. Then there were two circuses putting on two and three shows a day, and, of course, Madame Tussaud's Wax Works.

Then we come to greyhound racing four nights a week; wrestling and boxing at several places. Roller skating still is very popular and there are many rinks for this. Ice hockey is making great headway, every game being attended to capacity at nine rinks. Then, of course, there are numerous dance halls, cabarets, night clubs, *etc.* In addition, you can add football, radio, television and horse-racing.

The British Guild

Through the courtesy of Mr. James J. Finn of *International Projectionist*, I received an introduction to Mr. S. T. Perry, President of the Guild of British Cinema Projectionist and Technicians. This gentleman could not do enough for me and spared himself neither time nor trouble in making me acquainted with the workings and objects of the Guild and in arranging visits to theatres and the Pinewood Studios.

The Guild is strictly a technical and educational body with "Courts" in most of the large cities, and as they have no union affiliations, their efforts are entirely along educational lines. The Guild also publishes a very worth while paper every month containing reports of Guild work, articles on projection and news of interest to projectionists. Their membership is now over eight hundred. They meet frequently and have lectures and demonstrations by leading experts in all branches of work appertaining to projection and the theatre generally. They also arrange visits to many factories where projection equipment and its accessories are manufactured . . .

I was deeply impressed by the sincere and keen interest all the members of the Guild took in their work. They were well read and posted on all types of equipment and familiar with all the latest developments in projection and sound. All of which was reflected in the results on their screens; and it was interesting to note that Guild members receive a higher salary than most non-members.

I visited many theatres in various parts of England. In almost every instance there were three men on shift, usually a chief with a first and second projectionist. Every projection room included a separate rewind room, a rest room where the projectionists could have a smoke or sit down in comfort during his relief. Other rooms were provided for rectification, rheostats, stores, *etc.*, all of which were well ventilated. Every projection room also has to have a direct emergency exit to the outside. Another point was the cleanliness of everything: all floors covered, everything painted, and the equipment was spotless. All the theatres had remote control curtains, and all seemed to feature organs on hydraulic lifts at each performance.

Theatre Projection Rooms

There are two theatres I *wish* to especially mention, the Empire and Odeon, Leicester Square, London, both of which run about fourteen hours a day. In the Empire the equipment consists of three super Simplex projectors; H-C high-intensity Lamps, RCA push-pull sound heads; two high-intensity spots, and a Brenograph. Besides the fader units is a special selector switch panel to allow for the selection of any group of two projectors. The two amplifier racks set in the rear wall contain duplicate voltage amplifiers with a change-over switch and three 50-watt power amplifier units.

Adjacent to the amplifier racks is a special loudspeaker control panel containing a switch in the voice coil circuit of each of the ten loudspeakers, and an indicating fuse in one side of each loudspeaker field supply line. In this cabinet is also installed the loudspeaker coupling transformers.

Another cabinet houses the cross-over unit which divides the audio-power to the high- and low-frequency loudspeakers. The current for the loudspeaker fields is obtained from two wall-mounted tube rectifier units. A monitor amplifier is mounted on the rear wall. The monitor speaker is a permanent magnet moving coil speaker with metal horn. Power is supplied to all the equipment at all times during the performance, thus making it a matter of only a few seconds to complete a change-over in the event of failure of any unit. Duplication is also extended to the power supply for the equipment, as normally 1 4 kva. power transformer is used, but in the event of a failure of the a.c. supply, a special rotary convertor is available so that a change-over to the emergency d.c. supply can be effected.

The loudspeaker system consists of three low-frequency baffles, with wing extensions, each of these baffles having two 14-inch cone loudspeakers. Two cellular horns are provided for the reproduction of the higher frequencies. The horn covering the stalls (orchestra seats to you) has twelve cells in two horizontal layers of six cells each; and the horn covering the balcony has ten cells in two layers of five cells each. These horns are each driven by two loudspeaker units.

The Most Modern Room

The Odeon (opened on Nov. 2nd, 1937) is the last word in projection rooms. The equipment consists of three projectors, lamps and sound heads, two high-intensity spots, and a Ross Scenograph. The walls of the projection room are covered with blue tile, and the floor is of polished wood blocks. In the sound heads is one feature hitherto found only in the studio, the use of magnetic scanning drums. The film is scanned upon a drum whose shaft carries a heavy flywheel, driven through a magnetic coupling. This is a device the smoothness of drive of which has been found previously only on recording or re-recording heads.

At the back of the room, but actually away from the wall and easily accessible, are the amplifier racks. They are in duplicate throughout and embody the volume-expansion principle, which enables an increase in volume range of about 15 db. Duplicate speakers for stage and screen are controlled from this rack, which also houses the power supply units and deaf-aid circuits.

Another interesting feature in this rack is a combined photometer and sound-level meter. A spot of light moving across a scale is caused by a switch to record either the intensity of light on the screen or the volume of sound in the auditorium. The difficulty here is of course, that the reading of either is dependent less upon the projection and sound equipment than upon what is on the film, a dark picture or a low track modulation naturally giving low readings. As a photometer, the device is really of value only when it is possible to show on a white screen; nevertheless, this does permit a daily check to be kept on the general condition of all equipment, and prevents that gradual deterioration of arc mirrors and lenses which is so apt to pass unnoticed.

Another point I noticed is that the arc mirrors have what appears at first glance to be a sharp crack across one-half; actually this crack permits of free expansion and so reduces breakages. (How about this, I. P. readers?)

Thyratron Light Control

A piece of apparatus which I found full of interest is the thyratron lighting control system. Instead of the enormous bank of hand levers usually associated with a large dimmer system, all these controls are represented by small knobs or sliders, and the interlocking between different circuits, instead of being mechanical, is purely electrical. A small panel, three or four feet square, contains as many controls as would

(*Continued on page* 28)

Take-Up Troubles: How to Locate and Correct Them

By *A. C. SCHROEDER*

MEMBER, PROJECTIONIST LOCAL UNION 150, LOS ANGELES, CALIFORNIA

II.

TWO types of Simplex take-ups are shown in Figs. 3 and 4. The former is practically the same as the Powers 6-B take-up, except that it has a plain bearing, while the Powers had ball bearings. Fig. 5 shows the Motiograph take-up. A study of these three take-ups reveals the advantages and disadvantages of each. It still seems that for every advantage gained there must be a compromise.

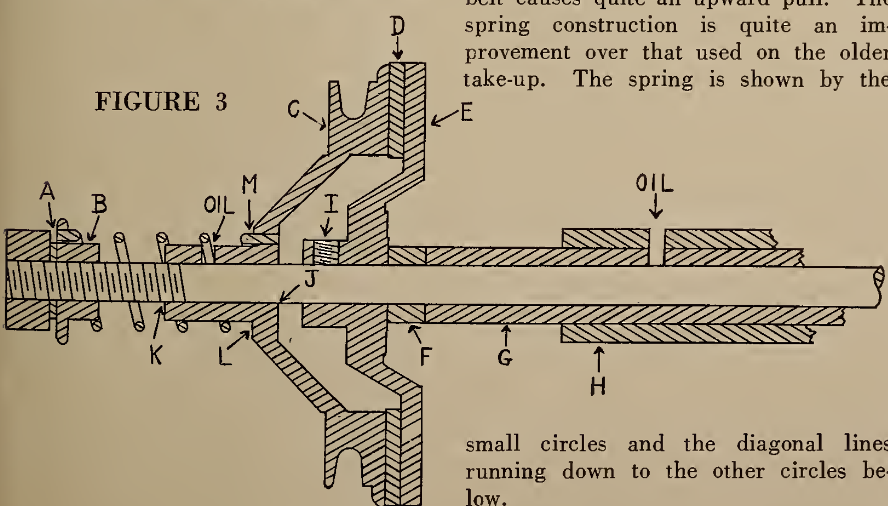
A heavy piece of friction material, D in Fig. 3, is fastened to C, the pulley driven by the take-up belt. D cannot wrinkle or wad-up into a clump as did some of the friction material used heretofore.

The spindle is driven by E, which is fastened by the setscrew I. The latter can be examined or tightened without disassembling the take-up, due to the construction of C, the sides of which are cut away, thus permitting the use of a screwdriver to reach I.

C turns on that portion of the shaft between J and K; while the belt runs in a groove about an inch to the right of J, which is not so good, especially if the belt is a bit tight.

The belt tension on the pulley tends to tip C, resulting in a concentrated pressure at J. This causes excessive wear and produces a shoulder on the shaft, which prevents C from sliding to the right and impairs the contact between D and E, resulting in poor take-up action and, frequently, complete failure.

FIGURE 3



The spring pressure against C tends to keep D in contact with E around the entire circumference, thus counteracting somewhat the tendency of C to tip due to the belt tension; but a shoulder will form at J nevertheless.

This shoulder must be removed with a file before normal take-up action can be had. To eliminate further trouble it is advisable to slightly reduce the shaft diameter at J. A small groove should be made around the shaft at J, so that C can move to the right without hindrance even when the shaft is reduced in diameter due to wear.

That part of C which forms the bearing on the shaft should come just flush with the left edge of the groove or extend *very* slightly beyond it. If the groove extends further to the left, it reduces the bearing surface and will result in even greater pressures here, causing other troubles later. The upward pull of the belt also pulls the spindle upward and causes a binding condition between the spindle and the bushing G. This was discussed last month.

Adjustment of Springs

Notice the oil hole in C, which may be hidden by the spring. There is a second hole to the right, displaced 90 degrees from the one shown. Both of these are quite important, as C is continually turning on the spindle and the belt causes quite an upward pull. The spring construction is quite an improvement over that used on the older take-up. The spring is shown by the small circles and the diagonal lines running down to the other circles below.

The end of the last turn, M, is bent at a right angle and placed into a hole, C. This makes the spring turn at a continuous speed equal to that of C. In the older take-ups the spring often has a jerky movement, causing a disquieting noise and producing uneven tension on the take-up reel. The left end of the spring is similarly turned at an angle and goes into a hole in the collar B, causing B to also turn at the same speed.

When assembling this take-up, put the spring back in the right way. The portion turned at an angle on the right end is longer than that at the left; the spring oan be put on wrong, but then the end projects through the collar B, and may touch the composition washer A or the adjusting nut on the end ot the spindle. A is usually too small in diameter to interfere with the spring end, but if it should, no particular harm would occur, other than to cock the spring slightly.

If A, B, and the adjusting nut are worn, the spring end may extend far enough to rub on the adjusting nut and will either cut a groove in the nut or it may catch where the nut is split, causing the take-up to lock—no slip occurring between D and E, but all slip taking place between the belt and the pulleys.

The washer A soon wears the parts on either side of it. Every day the collar B should be pushed to the right and a drop of oil applied between the surfaces. A brass washer might eliminate some of the wear at this point, or better still, a small ball thrust bearing could be used instead of the washer. It would have to be quite "thin," however, otherwise it may put too much tension on the spring, because B would be pushed farther to the right.

When too much spring tension ensues from inserting a ball thrust bearing, it is possible to slightly reduce the thickness of the flange on B. Not much stock can be removed here however, since the flange is only about ⅛ inch thick. The end of the spring must be ground off if it extends through the hole.

Alternatively, the surface L on part

C may be turned down. Although there is more stock here than there is on the flange of B, more metal is needed at L, so that this operation requires some thought. Unless one is able to decide on the proper procedure, it is best to consult a skilled machinist.

The purpose and the adjustment of the adjusting nut on the end of the shaft is obvious. The only precaution necessary is to again lock the nut after adjusting, failure to do which allows the nut to loosen, due to the rapid rotation of B, resulting in take-up failure.

G is a bushing in the magazine casting H. The bushing is held in position by a setscrew, not shown in the drawing. When installing this bushing it is necessary to align the oil hole in the bushing with the one in the casting H. Some endwise displacement is permissible, but this throws the pulley C out of line with the upper drive pulley and also displaces the take-up reel. Slight misalignment of C causes no trouble; but the reel alignment is important, so this is the point to watch.

Old Simplex Take-Up

Figure 4 shows the older type Simplex take-up. Again starting with pulley G, note that it turns on the extended portion of the bushing J. G is practically an independent unit: the only connection between it and the take-up proper is through three driving pins, one being shown at A. Thus, endwise movement of G has no effect on B or any other parts.

The bearing portion of G extends both ways from the plane of the belt groove, consequently there is no overhang and no tendency of G to tip from the belt tension. The belt produces no other strains on the shaft, either, thus from this standpoint it is almost ideal.

The pins A, of which there are three, are set firmly in G. They extend through holes in B. Possibly wear may occur on the pin where it contacts B, forming a shoulder on the pin and preventing the slight but necessary endwise movement of B. However, I have never seen or heard of such a condition. Probably this is due to the pins being situated well away from the shaft, thus having the advantage of the leverage produced by the comparatively large radius in which they revolve.

B might be called a floating member: it does not touch the shaft, as shown by the clearance at that point; it has clearance for movement around the pins A, and it is forced to the right by spring pressure through collar F. B contacts the friction member C, which in turn contacts the driving disc D.

The friction material C has "doubled over" in some instances and thus caused trouble. Various materials have been used by different projectionists, and in several instances the take-up has operated successfully for years without anything at this point, the part B contacting D directly. These friction surfaces are not very large, and the radius at which they work is a bit smaller than those shown in Fig. 3. However, this take-up has worked very well.

Remedial Measures

D is fastened to the spindle by setscrew K, which has occasioned our only trouble with this take-up. The setscrew loosens and eventually screws out, so that the disc no longer drives the spindle, causing take-up failure. This is particularly bad, as it is usually impossible to inspect this screw without taking the device apart; although sometimes B can be forced back against the spring pressure far enough to use a screwdriver.

Two remedial methods are available: a taper pin can be used, or another screw can be screwed down on top of the setscrew. When a taper pin is installed, some discretion must be used, as too large a pin weakens the shaft. Normally the shaft does not need much strength here, as there is no weight on it and the driving forces are inconsequential; but someone may bump against it accidentally and snap it off, if the pin hole is too large.

H, an oil hole, is often neglected—which neglect matters little, however, as this bearing invariably is flooded with oil. I is another oil hole and lubricates the shaft.

The two collars, F, position the spring and form a seat for it so that the pressure will be applied evenly. The collars and the spring are subject to the uneven movement discussed in connection with Fig. 3. Oiling the surfaces where they contact E and B helps produce the proper action.

We eventually became disgusted with the operation of these collars, and drilled a hole in the shaft in line with the small diameter of the collar B. A straight pin was driven into the hole, and then a slot was cut in the small diameter of F so that the pin engaged this slot, thus forcing the collar to turn with the shaft and preventing the former erratic gyrations.

The slot must be large enough so that the pin fits loosely in it, thus allowing the collar to slide along the shaft a small distance so that it may stay in contact with B. The pin should be flush with the small diameter of the collar to prevent interference with the spring which surrounds it at this point. The pin should fit snugly in the shaft, but even when loose, it cannot fall out when the spring is in position.

The Motiograph Take-Up

Figure 5, the Motiograph take-up, is of different construction. It is new to many of us, but is easy to understand. Those using it like it very much. The pulley I turns on an extended part of the bushing L, the same as the pulley shown in Fig. 4, and much of what was said regarding the latter applies to the Motiograph pulley.

It differs from Fig. 4 in that it forms one of the friction surfaces; also, it is forced to the right by C and the friction member D. It is prevented from moving to the right by the ball thrust bearing J, which is backed up by the magazine K.

There is no force to tip the pulley, and the belt tension does not effect the take-up shaft in any way. It is nearly an independent member, the only connection to the take-up proper being through the friction D. F is an oil hole for the pulley.

Part of the member C is drawn as it appears, and part of it is a sectional view. The drawing does not follow the exact construction (it deviates in only one particular) but it is simpler this way, avoiding possible confusion and in no way affecting the discussion. The shaded portions are the sectional view, while the jagged lines show where the breaks occur.

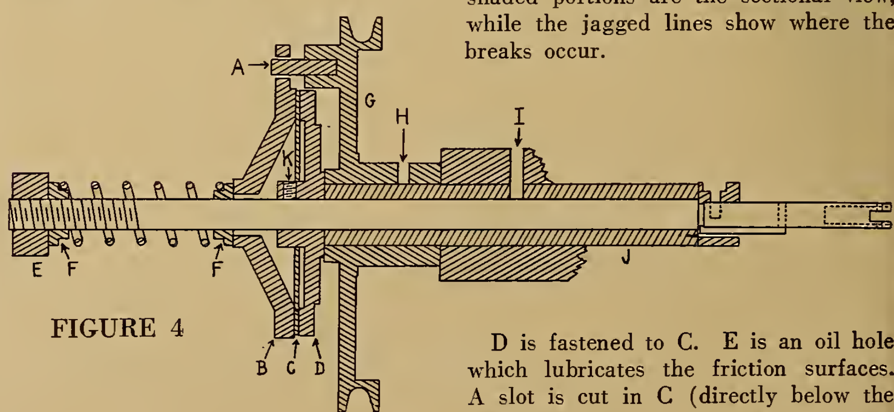


FIGURE 4

D is fastened to C. E is an oil hole which lubricates the friction surfaces. A slot is cut in C (directly below the letter C) into which a projection of part B fits. C is thus able to drive B, which in turn drives the shaft to which it is fastened by a setscrew, shown by the small circle. C is free to move along

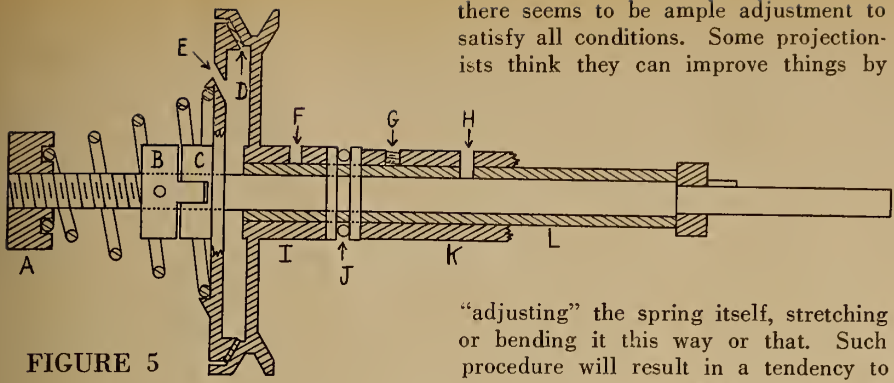


FIGURE 5

the shaft slightly, allowing the spring to force it to the right to take up any wear occurring where D and I contact.

The driving surfaces formed by B and C are fairly close to the shaft, and so the pressures are greater than they would be if the parts were larger. The surfaces between the tongue and groove should be kept oiled, so that C will be perfectly free to move endwise.

Small shoulders may form on these parts, but they will be such that they force C and D into closer contact with I, and should cause no trouble, except possibly the need of loosening the spring tension a bit. If, however, they cause erratic action, it is a simple matter to remove them with a small file.

● Proper Fit Important

If the fit between C and the shaft, and the fit between the tongue and groove, are too snug, they prevent free movement of C along the shaft, thus impairing the contact of D and I.

This is particularly so if the parts are not perfectly true, which, however, is unlikely. If D and the hole in C are not concentric, inspection of D will show if only portions of it are contacting I. Similar inspection of the shaft hole in C, if it is the seat of the trouble, will show a bright portion. The bright patches may then be removed by careful work with a rat-tail file. If the trouble is between B and C, the high spots may be removed with a flat file. Try to ascertain if there are high spots, or if the fit is just too tight, all surfaces being flat as they should be. If the surfaces are flat, then either the tongue or those in the groove may be filed; but it is best not to file both.

Filing the tongue and groove members is risky business, however. If done improperly, it makes conditions worse not better, causing I to run eccentrically or to wobble. Of course, if binding occurs here, the surfaces *must* be relieved; but make certain where the trouble is before starting.

The small end of the spring seats in a groove in the adjusting nut A; the large end in an annular projection on C. It is a large conical spring and there seems to be ample adjustment to satisfy all conditions. Some projectionists think they can improve things by "adjusting" the spring itself, stretching or bending it this way or that. Such procedure will result in a tendency to cock the part C, causing uneven pressure around the circumference of D or causing C to bind on either the shaft or on B. This will obviously impair the operation, and a new spring must then be installed.

Since the spring seat on each end revolves with the shaft, there is no tendency for them to turn at a varying rate of speed. It is unnecessary, therefore, to lock the adjusting nut on the spindle. Thus we have a very desirable feature: we can turn the adjusting nut while the machine is in operation, either loosening or tightening it at will.

G is a setscrew holding the bushing in position, and H is the oil hole. What has been said about the bushing in Fig. 3 also applies here.

A source of trouble on various take-ups is the reel lock at the magazine end of the shaft. A fairly heavy spring within the shaft forces a plunger out against the reel lock. The latter is pivoted on a small pin, which must take the entire pressure of the spring and, due to the movement on it, sometimes wears through, resulting in the parts being thrown out onto the floor. Finding them is like hunting for the proverbial needle.

When the reel lock is not swung over carefully, it is sometimes forced in a direction at right angles to that in which it should normally move. This forces the small projecting ends (shown in Fig. 4) apart and makes it difficult for the reel to be placed on the shaft or to again remove it. In some instances these shaft projections have actually been broken off.

The Practice of Projection†

By *ALFRED N. GOLDSMITH*

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The appended paper was read by Dr. Goldsmith to open an S.M.P.E. Convention Projection Session over which he presided. Known throughout the scientific world for his engineering achievements in radio, television and motion pictures, Dr. Goldsmith has long been an ardent champion of good projection and a warm friend of the projectionist craft.

IT IS natural that there should be a Projectionists' Session at any important convention of the Society of Motion Picture Engineers. For one thing, a motion picture engineer can not be truly qualified in his profession if he does not know of the status of projection and of the problems in that field that still await solution.

The engineer can not hope to learn of these problems from his inner consciousness or work out their practical answers by a feat of imagination. It is only by being in close contact with the projectionists who are skilled in the practice of their art and who daily encounter the problems in question that the engineer can be guided aright and can hope to produce workable equipment and methods that will advance the art of projection. Solely by close and continuous cooperation between the skilled projectionists and engineers can apparatus be produced that will stand the harsh test of everyday wear and tear.

But this is only a small part of the reason for a Projectionists' Session at an SMPE convention. As has been correctly pointed out, projection of the motion picture and reproduction of the related sound constitute the "neck of the bottle." The motion picture industry has gone to enormous pains to produce an appealing and valuable product. Vast studios having the most modern equipment have been built. The most popular stories and most successful plays are purchased for motion picture adaptation at figures that truly approach "colossal." Stars of the first magnitude are selected as the chief players, and at rates that are truly "awe-inspiring."

Large groups of writers, re-writers, and specialists in the literary polishing of the script bend their efforts to producing the best results on the set. Cameramen, sound recordists, electricians, make-up men, wardrobe mistresses, carpenters, painters, and a host of others form an army under the command of the most capable directors. Editors and cutting-room experts toil

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through weary months to produce the smoothest and most appealing film.

Elaborate sales and distribution systems carry the films to every corner of the land. A myriad of sparkling and attractive theatres with bright lights blazing in the lobbies and the names of the stars and the play in twinkling lights overhead attract the audience. A whole branch of the advertising industry is devoted to acquainting the public with the romance of the film presentation. Comfortably upholstered chairs, spick and span ushers, air-conditioned theatres, and other instances of efficient management are added to complete the attractiveness of the theatre.

And now we finally reach the merchandise—if so prosaic a name may be used—that it is proposed to sell. And this merchandise is nothing more than foot-lamberts from the screen and acoustic watts from the loud speakers. These are the neck of the bottle, and it is for these that the audience pays—or does not pay.

And these all-important elements in the motion picture industry—the sole and final reasons for its existence—are under the care of the projectionists. If the engineers have provided proper equipment in the projection room, the projectionist then determines the quality and reliability of the performance. He is really the physical impresario of the motion picture presentation. Failure of equipment or incorrect handling can annul all that has gone before.

The aim of the projectionist is to produce pictures that are sharper, steadier, and (within limits) brighter than heretofore. Much can be said in detail relative to each of these requirements. Nevertheless, broadly, they cover the field. At the same time, more perfect and realistic sound reproduction is also the aim of the projectionist.

Many elements in the field of projection are in a state of evolution—illuminating sources, projection room equipment and routine, color projection, and many other developments.

It is clear enough why there should be a Projectionists' Session at any SMPE convention. Indeed, it would be difficult to pick any element in a convention that was more necessary than this session, which, like those that have preceded it, will contribute to the pleasure of future theatre audiences and the prosperity of the industry that the engineers and projectionists alike will serve.

EDUCATIONAL REQUISITES OF THE MODERN ELECTRONIC INDUSTRY

By *J. K. WHITTEKER*

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Numerous requests for information bearing on the title of this article reach I. P.: from fathers solicitous for their sons' progress, and from younger members of the craft who would like to embark upon advanced engineering work. While this article was written specifically for and is directed to those who have not as yet entered upon their secondary schooling, it is broadly applicable to all who are interested in this topic.

MUCH has been said about the necessity of technical training for radio engineering, but little has been made of the type of student upon whom it should be bestowed. Not every boy is suited for engineering work any more than every boy has the aptitudes which go to make a good lawyer or doctor. Too frequently one hears the remark, that since a certain family has insufficient funds to give their boy a medical or legal training, they have decided to send him to an engineering school. Such haphazard decisions eventually result in disappointment to all concerned.

So complex are the qualifications necessary to the potential engineer that a decision to enter the profession should not be made without due deliberation and careful analysis. Many tests have been developed for the testing of aptitudes and it is quite possible to determine a boy's fitness for any profession with considerable accuracy.

It should be borne in mind that radio engineering is not a junk yard into which may be dumped those young men who, because of obstacles real or imaginary, or because of poor mental ability, are prevented from entering other professions. As in other careers, the boy's preparation for entrance into a radio engineering school should begin as early in his secondary school life as prognosis of his engineering abilities can be made. Although such prognosis can be guided by the child's hobbies, these activities should not be taken too seriously.

"What," you may ask, "is to be found in a high-school record that gives a clue to a boy's aptitudes?"

Math Vitally Important

Junior's record, let us say, indicates a minimum schedule in mathematics and the sciences, but a maximum schedule in the art subjects. The record of the boy next door, on the other hand, shows a maximum schedule in mathematics and the sciences, and a minimum in the arts. Therefore, since all engineering consists largely of a mixture of mathematics and physics seasoned with economics, it is quite evident that the boy next door has a better chance in radio than Junior, assuming that in each case the subjects taken are of the boy's own selection.

As has been mentioned previously, the importance of adequate secondary school preparation for the embryo engineer cannot be over-emphasized. English should be studied throughout the entire four years, not only to gain facility in expression but also to read with comprehension.

As in English, four years, if possible, should also be devoted to the study of mathematics. This subject, the universal language of science, is a mode of expression understood by technical people of all tongues. As many of the following mathematical courses should be studied as the school curriculum provides: elementary, intermediate, and advanced algebra; plane and solid geometry, and trigonometry. Not only is mathematics a required subject for entrance into professional schools, but it is also a most valuable item for prognosis of one's scientific abilities.

Favored Elective Subjects

The sciences form a third group of secondary school subjects required for professional school entrance and usually consist of general science the first year, biology the second year, chemistry and physics the third and fourth years. While some question including biology in engineering school preparation, the value of its training in scientific methods and procedure should not be overlooked. A student's progress in this third group of courses, when correlated with that in mathematics, provides an excellent measuring stick for determining the boy's fitness to enter the engineering profession.

The fourth group of prepared subjects will be determined by any additional subjects required by the professional school which the student intends entering. If the subjects, additional to group one, two, and three, to make up the requisite fifteen points for entrance, are optional, the student will do well to devote two years to history, one year to political science, and one year to economics. Among the

(*Continued on page* 26)

THE audience at the technical session held during the recent I. A. Convention in Cleveland was not as large as I should have liked it to be, but it constituted a good showing for the first such session ever held at a convention. The most interesting presentation was that by General Electric Co., dealing with optical systems and exciter lamps. The information was mostly elementary but the explanations were exceptionally clear, particular emphasis being placed upon the use of the right exciter lamp with a given optical system.

National Carbon Co. ran a two-reeler which traced the manufacture of projector carbons. Hickok Instrument Co. presented a blackboard talk relative to a vacuum tube voltmeter[1] which will apparently do everything for the projectionist except wash his socks. RCA representatives proved exceptionally helpful. I was unable to bring my own oscilloscope to Cleveland, but the RCA delegation obligingly supplied one of their service engineer's cathode ray jobs—a very fine gesture on their part, particularly in view of some disquieting activities by RCA men in the past in Ohio. The RCA delegation at Cleveland boosted their company's stock 100 per cent with the I. A. T. S. E. delegates in attendance.

Practically everything I used in my demonstration was new and untested, but, strange as it may seem, all units worked well. Instead of breaking in my lecture and equipment with small audiences, I had to pick on the most critical audience extant—an I. A. Convention. But not a single rock was thrown.

Prospects for a restful summer have been blasted by an increasing number of bookings for lectures on popular science before various service and educational clubs. A professor at the Univ. of Wisconsin has booked me for a demonstration on sound reproduction before an audience of about 6000 at a Lakeside, Ohio, auditorium. The auditorium must have been copied from the Goodyear hangar at Akron, as it is simply a half-cylinder with a floor about two city blocks long and one block wide, with about 6000 seats down the middle and at one end a stage about 150 feet wide. I will have to utilize a pair of 200-watt amplifiers on this job—thanks to the nightmare that produced such specifications.

Appended hereto are my introductory remarks during the demonstration given at the Cleveland I. A. meeting.

Public Relations Vitally Important to Labor Union Progress

By *THEODORE P. HOVER*

SECRETARY, I. A. T. S. E. LOCAL UNION 349, LIMA, OHIO

For many years the author of this article has been preaching the doctrine of intensive labor union participation in civic affairs—and his own particular Local Union, adopting his principles, has profited handsomely. So, too, can every other labor organization, irrespective of size or locality.

HERETOFORE, organized labor has sat quitely at home, so to speak, secure in the knowledge that its policies were right and assuming falsely that this was all that was necessary. The rise of radical labor groups has induced a storm of unfair publicity directed at organized labor, and the ranks of the legitimate labor unions have been deluged by this same storm. Events of the past year have convinced labor leaders that a change in tactics must be brought about immediately if organized labor as a whole is to retain its standing and reputation as a legitimate enterprise.

As might be expected, the press, and to a lesser degree the radio, is always open to anyone who would criticize Labor. Prominent feature writers make no secret of their antagonism to Labor, nor of their efforts to put Labor in the worst possible light before the American public. Disgruntled and discredited columnists and scandal sheets, failing to impress the public with their attacks upon Labor as a whole, scandalize and attack the personal lives, politics, and religious activities of labor leaders themselves, and, somehow, never seem to lack an audience.

● Labor's Side Slighted

The Kaltenborns, Forbes', and Lawrences use the freedom of the press to condemn and belittle the very people whose organized activities have preserved for them their freedom of public expression. The utterances of radical and socialistic leaders receive front-page attention, while the conservative and legitimate labor leaders' remarks will probably appear along side the obituary column.

It is apparent that our present era has brought about an illegitimate marriage between manufacturers' associations, chambers of commerce and the press. To believe that the children of this marriage should be of any assistance whatever to the workingmen of America, is to expect white children from black parents. Not all the fault, however, can be placed upon the press. Organized labor as individuals, as locals, and as state and national bodies are equally to blame. The personal knowledge that we may be right means nothing unless we can convince 125,000,000 people that this is so. To do this requires a careful program of publicity and vastly improved public relations.

It is my wish to bring this matter to the attention of the delegates here assembled. A majority of local unions have solved their public relations problems by saying, "Let the state body take care of it;" but publicity, like charity, must begin with the individual member and reach its greatest prominence as an integral part of the business policy of every Local Union.

Practically the only publicity relative to amusement industry workers that has been presented to the public during the past few years has been distinctly unfavorable and very much to our disadvantage, the outstanding nugget of information being that even the lowest-paid projectionists received salaries comparable with those paid to the governors of their respective states. In my own city, in order to receive the wholehearted cooperation of the Central Labor body, it was necessary to show the members at large one of our existing contracts proving that our members received the sum of $35 per week rather than the $105 per week which they believed to be our salary. Their information had come from the manager of an unfair theatre whom we were then battling.

It should be remembered that the relations between theatre employees and the public are closer than those of any other craft. A part of the dollar which John Q. Public pays in at the box office on Saturday afternoon will probably be found in the employee's pay envelope on Saturday night. There is no extensive round-about financial system involved, and, needless to say, if the public does not patronize the theatre, the projectionist and stagehand won't be paid.

This has been proven repeatedly in theatres which have been picketed by I. A. members. In these cases we did not win the strike or lock-out, but public

[1] "A Zero-Current Meter for Projection Room Use", by Robert Garwin, in I. P. for May, 1937, p. 22.

opinion and co-operation did. How much better it is to have the friendship of the theatre-going public before we need it, rather than waiting until the last minute when trouble strikes and then try to accomplish in a few weeks or days that which common sense tells us requires months and even years.

● Contacts Mean Advances

Public relations programs, to a greater or lesser extent, have been a part of the normal proceedings of a number of our larger I. A. locals, some of which have achieved outstanding success. Is it mere coincidence that some of the locals with successful publicity or contact departments have the highest wage scales and superior working conditions?

No attempt can be made by officials of one local to point out what another local should do. But the writer personally believes that a most effective method of improving public relations is to attain a favorable spot in the local newspaper and stay there. If it should become necessary for the officers of any local to make the supreme sacrifice of going out and kissing babies and laying corner stones in order to secure favorable publicity, let us remember that many a politician has achieved success by doing just that.

A few outstanding public contacts deserve attention. The Local should be on good terms with the governing body of the city, such as the mayor and city council. In this, a Local which has its membership listed as 100 per cent registered voters will have made an excellent start. Co-operation in civic affairs will assist in cementing a bond of friendship. There is no reason whatever why locals should not have a representative among the membership of their city's most important service clubs such as the Kiwannis, Rotary, or Lions, especially since these organizations are frequently on the front pages of the newspapers. They offer a fertile field for sowing the seeds of proper understanding and co-operation with organized labor.

● Law-Enforcement Contacts

Friendship with the police department is not to be sneezed at, especially if it becomes necessary to establish an extensive picket line. Many a law enforcement officer's voice has been lowered by the knowledge that passes to a local theatre might be forthcoming. Close association with welfare agencies offers an excellent means of favorable publicity (social climbers have been doing it for years). Many locals have given unselfishly of their time and funds so that under-privileged children not only be furnished with the necessities of life but also see an occasional movie, the film being donated by the theatre and the projectors and services by the Local. Members might be surprised at the wealth of personal satisfaction and public appreciation which they will receive by interesting themselves *as a group* in an orphan asylum or children's home and assisting in presenting an occasional show.

● School, Church Fields Fertile

Schools, both public and parochial, also offer a fertile field for the publicity department. Parochial schools are much easier to contact than might be expected, inasmuch as the Catholic clergy from the Pope down to the priests and nuns have taken a militant stand in defense of organized labor's rights. Not only can the Local offer assistance to the visual instruction department of schools, but by close co-operation in the service and maintenance of their equipment they can prevent school projection rooms from being used for training non-union operators or the presentation of unfair attractions.

Sports should not be neglected as an activity: handball, bowling, or soft-ball teams furnish valuable publicity and will develop a spirit of co-operation among the members themselves. The business agent of any local whose members are interested *as a group* in some form of outside activity—whether it be welfare work, politics, education, or sports—will find that the same united front necessary therefor will prove useful in maintaining a united labor front.

There is another important activity of vital importance to projectionists everywhere and that is the Society of Motion Picture Engineers. Our organization as a whole is outstanding in its poor representation with this body. Each year vital decisions, many of which concern the welfare of our own members, are made by the Projection Practice Committee, which, instead of being composed of outstanding projectionists and theatre technicians, is largely controlled by chain circuit executives and those, who, while sympathetic to our organization, lack the real understanding to properly aid our members. There are, of course, a few outstanding exceptions on this committee. The I. A. members, few as

S.M.P.E. Projection Committee Recommendations are Cited as Proposed American Standards

THE appended recommendations of the Projection Practice Committee of the S.M.P.E., including the table relative to screen sizes, have been cited by the Standards Committee of that body as a proposed American standard. Favorable action by the American Standards Assoc. will validate the proposals.

Projection Lens Height.—The standard height from the floor to the center of the projection lens of a motion picture projector should be 48 inches.

Projection Angle.—Should not exceed 12 degrees.

Observation Port.—Should be 12 inches wide and 14 inches high, and the distance from the floor to the bottom of the openings shall be 48 inches. The bottom of the opening should be splayed 15 degrees downward. If the thickness of the projection room wall should exceed 12 inches, each side should be splayed 15 degrees.

Projection Lens Mounting.—The projection lens should be so mounted that the light from all parts of the aperture shall traverse an uninterrupted part of the entire surface of the lens.

Projection Lens Focal Length.—The focal length of motion picture projection lenses should increase in ¼-inch steps up to 8 inches, and in ½-inch steps from 8 to 9 inches.

Projection Objectives, Focal Markings.—Projection objectives should have the equivalent focal length marked thereon in inches, quarters, and halves of an inch, or in decimals, with a plus (+) or minus (—) tolerance not to exceed 1 per cent of the designated focal length also marked by proper sign following the figure.

S.M.P.E. Standard 35-mm. Projection Screen Sizes

Size No. of Screen	Picture Width (Feet)	Picture Height, Feet	Picture Height, Inches	Size No. of Screen	Picture Width (Feet)	Picture Height, Feet	Picture Height, Inches
8	8	6	0	25	25	18	9
9	9	6	9	26	26	19	6
10	10	7	6	27	27	20	3
11	11	8	3	28	28	21	0
12	12	9	0	29	29	21	9
13	13	9	9	30	30	22	6
14	14	10	6	31	31	23	3
15	15	11	3	32	32	24	0
16	16	12	0	33	33	24	9
17	17	12	9	34	34	25	6
18	18	13	6	35	35	26	3
19	19	14	3	36	36	27	0
20	20	15	0	37	37	27	9
21	21	15	9	38	38	28	6
22	22	16	6	39	39	29	3
23	23	17	3	40	40	30	0
24	24	18	0				

they are, have achieved lasting recognition for their work. That this matter is important is shown by the fact that at the last two meetings of this engineering organization our International President has been personally represented. A goal of at least one member in the S.M.P.E. from each Local would quickly answer the question posed when various equipments are received for installation, namely, "Why did they build it this way?"

I now present the ideas which we used to secure favorable publicity for ourselves and our local in the city of Lima. This demonstration is not recent in origin. The first attempt along this line was made by a former member of our Local, now a member of Local 160 of Cleveland. It was in the form of a lecture and a short demonstration dealing with movie making, projection, optics, electricity, *etc.*, and was given before science classes in Lima High Schools as early as 1917.

The advent of sound widened the field for interesting demonstrations. Our presentation tonight is the outgrowth of one presented more than 20 years ago by that grand old man of projection, Mr. Peterson, under whom I had the honor to serve my apprenticeship.

As originally stated to your Program Committee, this demonstration is not of value to the members of the craft, for it deals with matters with which we are overly familiar. However, to the layman who still believes that the sound comes from a phonograph behind the screen and that the projectionist cranks his machine by hand, this demonstration is a revelation. It has been presented before high schools, Kiwannis and Rotary clubs and allied organizations for the purpose of showing that the projection of pictures is a profession requiring skill and technical ability, facts which they never realized previously.

We wish to point out for the benefit of the technically-minded members and to save embarrassing questions, that, because of the limitations of our equipment and the fact that our audiences are always non-technical, portions of our demonstration are a bit over-exaggerated and scientific truths have been twisted slightly for simplicity in presentation. (NOTE: Subsequent demonstration by Mr. Hover was described in detail in I. P. for March, 1938, p. 11, under the title: "Co-Operation as the Keynote of Good Projection Service.")

Taylor Winner in Contest Finale

H. D. TAYLOR of North Carolina, suh, after hovering around the top of the heap throughout the Contest, crashed through to win first honors in the final series of questions. Right behind Taylor was Lawrence Borgeson, a two-time winner of top honors and a consistent high-ranker. Everett Renfroe and James Day took over the next two slots, but only by a narrow margin from J. A. Johnson, Theodore Hover and T. Morisawa, all of whom tied for fifth place to win consolation prizes. Here are the winners:

First Award
H. D. TAYLOR
705 W. South St., Raleigh, N. C.

Second Award
LAWRENCE BORGESON
454 El Molino Ave., Pasadena, Calif.

Third Award
EVERETT RENFROE
4633 So. Wabash Ave., Chicago, Ill.

Fourth Award
JAMES A. DAY
14825 Kentucky St., Detroit, Mich.

The contestants experienced greater difficulty with this group of questions than with any other, judging by the answers submitted, Taylor being the only one to maintain a uniform pace throughout. Even some of the prize-winners slumped badly on one or two questions, their answers ranging from very good to very poor. Other contestants "killed" one question and then were unable to score even a few points on another query. Spotty work such as this has highlighted the Contest.

Papers of all Contest winners are now being checked to determine the winner of the grand award for the best group of answers submitted, announcement of which will be made in the next issue. It is possible to say now that the prize lies between Borgeson and Renfroe, both of whom consistently ranked high.

The best answers to the final series of questions are appended hereto:

21. Complete loss of sound has been traced to Fig. 2. Headphones show somewhat lowered volume across R-5, lowered volume across the primary of the output transformer. What would you do?

By K. P. KENWORTHY

There is a break in the circuit between the output transformer secondary and the output terminals. This may be a dirty contact at the impedance matching switch, a faulty soldered joint or connection, or a broken wire. I would try the switch on the other contact before checking elsewhere, as this will clear the trouble if the circuit is open inside the transformer case, or if the switch contact is dirty. If necessary, the set can run temporarily on the wrong contact, with some loss of volume and quality, however.

The reduced volume noticed across R5 is due to the fact that the reverse feedback, normally in parallel with the low-impedance speaker load, is now the only load on the output, and the portion of the output energy fed back is greater than normal, exerting more than normal reduction on the gain in the first stage.

[ED.'s NOTE: *Contestants who seem to know their sound quite well slipped up on this question by failing to take all the symptoms into account. Thus, some suggested testing the amplifier B circuits, obviously overlooking the fact that sound was heard (at lowered volume) as far as the primary of the output transformer, while the speakers had no sound at all. Others again suggested trouble in the input stage, also overlooking the complete loss of volume between the output transformer primary and the speakers. Still others attributed the fault to the loud speaker lines, forgetting that it had been definitely traced to Fig. 2. More careful reading of the question would have resulted in a number of higher scores; similarly in actual trouble shooting all the symptoms must be considered at their proper worth.*]

22. The tube in the upper socket of the push-pull pair of Fig. 2 burns out often, stopping sound entirely. Between burn outs meter fluctuation is noted when the meter switch is thrown to the right. What would you do?

By JAMES A. DAY

The term "burn out" as used in the question is rather indefinite and confusing. As generally used it would apply to a tube in which the filament had burned out; while the term "failure" is usually applied where loss of filament or cathode emission is intended. It is not likely that any trouble could develop which would repeatedly burn out the filament of one tube without affecting others in the amplifier, as the filament wiring is heavy, of low resistance, and all tubes except the rectifier are connected to the same secondary winding. If there were high voltage on one filament, it would be high on the others. Therefore, it is assumed that "burn out" as used in the question means tube failure due to loss of emission.

If the phase inverter and both tubes of the push-pull pair were working, failure of the upper right-hand tube would not cause complete loss of sound in any case, except that of a grounded control grid, shorted elements, *etc.*; in modern tubes such troubles do not occur repeatedly. This would indicate trouble in the lower right-hand tube, such trouble being the cause of the upper tube's failure.

As the 6L6 tubes draw heavy plate current, and their load keeps the plate supply voltage down to its proper level, it is understood that an "open" in the plate circuit of one tube, or failure of one tube to draw its proper load current, will cause excessively high voltage on the other; and the increased current will soon ruin the remaining tube. With only one tube of the push-pull pair working, the meter reading the plate current would fluctuate with sound.

(a) Coupling condenser C6 may have shorted, putting a positive bias on the grid of the lower tube, causing it to draw excessive plate current and to fail. Failure of the remaining tube soon follows.

(b) An open circuit between the center tap on the primary of the output transformer

and the tube plate may be causing the trouble.

In (a) either borrow C7 or C8 and use in the place of C6 temporarily, or disconnect C6. Install two new 6L6 tubes. Connect low-end adjustment or feedback circuit to the center position until C6 is replaced and C7 or C8 is returned to its original position. If C6 is merely disconnected, the amplifier may be used until repairs can be properly made, the lower 6L6 not passing sound but acting as a ballast on the power supply to keep the plate voltage on the upper tube from rising.

At (b) if it is found that the open circuit is in the lower half of the primary of the out-put transformer, the show may be continued by connecting the plate of the lower tube directly to the center tap of the primary of the output transformer, and allowing the lower tube to act as ballast, as explained previously. The output transformer to be replaced as soon as possible.

[Ed.'s Note: *Contestants justly objected to the use of the phrase "burns out" to define failure of the upper 6L6 tube—a bit of carelessness on the part of the writer. 6L6 filaments do burn out on plate-cathode flash-over, due to puncture of the insulating sleeve, and grounding of the filament current via the cathode. In this case, however, the writer should have noted, before phrasing the question, that the 250-ohm grid bias resistor will effectively prevent filament current from returning to ground in that way. The tube becomes inoperative, nevertheless, due to loss of cathode material and decreased emissivity. A number of the contestants adopted that interpretation and wrote their answers accordingly.*]

23. With the low-frequency filter strap of Fig. 2 set at maximum l. f. volume (center position), low-frequency response increases suddenly. The effect can be heard with headphones across R-5, but sound across R-1 is normal. What would you do?

By H. D. TAYLOR

Examination of 1 and 2 points to the reverse feed back circuit and the left hand tube. Normal sound across R-1 clears C-1 and C-2.

For this trouble I would check the r.f.b. circuit. With the low-frequency adjustment already set for maximum low frequency, I would look for the trouble at other frequency controlling factors of the circuit.

At low frequencies, the impedance of C-14 or C-15, .005 mf., or both of them paralleled, .01 mf., in series with the voltage divider section, is quite high as compared with the remainder of the r.f.b. circuit. A leaky C-14 or C-15, or a short-circuit around them, would lower the impedance of this branch of the circuit to the low-frequency voltage tapped at the output. The effect of this lowered impedance would shunt low-frequency voltage out of the r.f.b. circuit, preventing it from reaching the input of the left-hand tube as degenerative voltage, and causing an increase in the low-frequency response of the amplifier. If a ground or a short were found here, I would remove same. If defective condenser were found, I would disconnect same. If normally both condensers, .01 mf., were connected, and replacement not at hand, I would disconnect defective condenser and use only one .005 mf., or replace both of them with a single .01 mf. condenser until replacement could be made.

Another possibility would be an open at or in R-18 or R-19. This would allow only high-frequency degenerative voltage to reach the input of the left-hand tube, through the high pass adjustment of C-16 to C-20 and P-1, which would increase the low-frequency response of the amplifier.

If R-18 or R-19 couldn't be replaced, or any other trouble of the r.f.b. circuit could not be found and removed reasonably quickly, I would disconnect circuit at terminal 1 or 2 R.V.C. and readjust volume for emergency operation until trouble could be cleared.

Another possibility to check is a dirty or corroded contact at the slider of P-1, which would offer a high impedance to the low-frequency degenerative voltage.

[Ed.'s Note: *The best answer to this question omits some possibilities that were mentioned in other answers which, however, scored lower as a whole. In particular, decline of capacitance in the electrolytic condenser, C-3, would account for the conditions described. The winning answer also fails to point out that the trouble can be adjusted temporarily, pending more complete investigation, by setting the low-frequency filter jumper either to R-*16 *or R-*17.]

24. In a case of complete sound outage in Fig. 2, headphones show somewhat increased volume across R-5, no sound across the primary of the output transformer. All filaments light, meter reads normally, and all socket voltages check normally. What would you do?

By LAWRENCE BORGESON

The fact that volume is heard across R-5 indicates that the amplifier to that point is alright. The increased volume across R-5 is due to the fact that there is no feed-back, because there is no signal voltage across the secondary of the output transformer. Since all meters are reading normal, as are all tube socket voltages, we know that all the tubes are o.k., and that A, B, and C power is o.k. No sound across output transformer primary indicates that there is no signal reaching this point. Therefore, there must be an "open" somewhere in the speech circuit so located as not to upset any of the d.c. potentials. A short or ground in the speech circuit would reduce the volume across R-5, except in the special case given in (3) below.

I would proceed as follows:

1. When testing across R-5, I would also test across R-22. No sound indicates an open circuit between R-22 and R-5. I would check the wiring for a loose connection and then I would check C-5 for open circuit. If the trouble found were due to a loose connection, I would repair it. If an "open" in the condenser, I would replace it. There might be an open circuit between R-5 and C-5, in or at C-5, or between C-5 and R-22. Connection must be good between R-5 and wire to plate of first 6J7.

2. If sound were heard at R-22, I would then test across R-6 and R-7 (*i.e.*, between upper side of R-6 and the lower side of R-7). No sound would indicate an open circuit between R-22 and R-6, due to broken wires or a loose connection. If a bad connection at the top of R-6, there still must be contact

Projection Equipment Display Draws Crowds

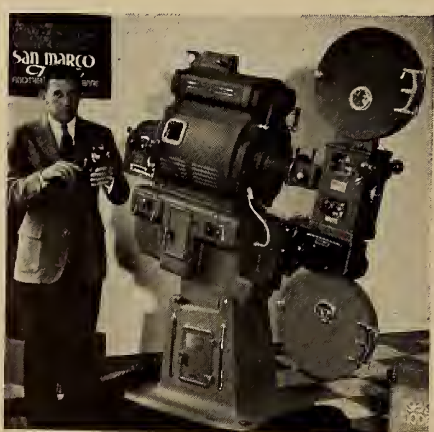
THE writer recently arranged a display of motion picture projection equipment in Jacksonville that proved enormously popular with the public. It is estimated that more than 40,000 persons saw this exhibit.

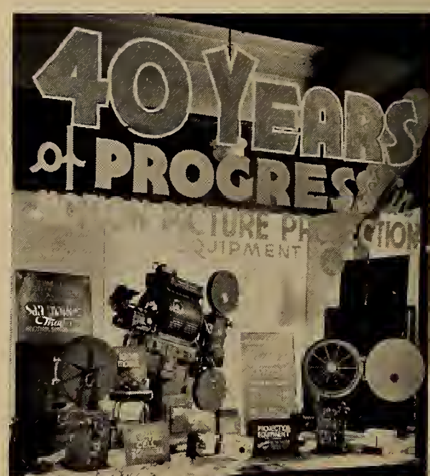
The display showed the progress of projection equipment during the past 40 years. Projectionists were kept in the exhibit to explain the functioning of the various visual and sound projection units. The writer is pictured holding an ancient model Motiograph projector (manufactured in 1898 under the name of Optigraph) in contrast to a modern Motiograph.

The writer has owned this tiny projector for 18 years, having unearthed it in one of the local theatres. The projector is in excellent condition; in fact, during the exhibit a film was actually projected by it and the projection was remarkably steady. The intermittent movement is of the two-pin type and has a barrel-type revolving shutter located between the objective lens and the film aperture. There is no take-up, the film being fed into a gunny sack.

Maybe these pictures and accompanying few words will serve to get other projectionist groups to sponsor similar exhibits with comparable success.

B. A. Cawthon
Dir. of Projection, United Theatres
Jacksonville, Florida





between R-6 and the wire going to the upper 6L6 grid, otherwise bias would be lost. Trouble located would be cleared by re-soldering connections or replacing broken wires.

3. (1) and (2) are the most likely causes, but one other possibility is a high-resistance connection at the right side of C-5, at the junction of C-5 and the top of R-22, or at the junction of the wire between R-22 and the top of R-6; and at the same time a ground somewhere to the right of the high-resistance connection. The high resistance would prevent decrease in volume across R-5; and the ground would short the speech circuit, but would not upset bias or tube voltages.

I would check (as a last resort) for such a trouble by connecting the headphones between the top of R-6 and bottom of R-7. If no sound, I would measure the resistance between R-6 (top) and R-7 (bottom). A short would obviously show up by such a test. By repeating this test across R-22, and then from right side of C-5 to ground, the point of high resistance could be found. Using the ohmmeter, a test could be made between the right side of C-5 and, successively, the top of R-22 and the top of R-6, thus indicating the point of high resistance. I would clear the ground and resolder the high-resistance connection, or squeeze with pliers for temporary clearing of the high-resistance connection.

[Ed.'s Note: *The suggestion that, in the absence of a spare for C-5, if defective, that condenser may be replaced temporarily by borrowing either C-7 or C-8, is not included in the winning answer. Such replacement, while not wholly satisfactory, will enable the show to go on.*]

Those few contestants who submitted papers averaging fifty per cent correct or better were:

Calvin E. Mervine, Pottsville, Penna.; K. P. Kenworthy, Moscow, Idaho; Chester A. Ellison, Reading, Mass.; Carl Rossi, Brooklyn, N. Y.; W. Fenwick, Victoria, Canada; Ray Mowery, Mahanoy City, Penna.; Leo Cimikoski, Norwich, Conn.; J. T. Kirkham, Calgary, Canada; Frank Swalbert, Buffalo, N. Y.; Bill Johnson, Kimball, Nebr., and Walter Fink, Mahanoy City, Penna.

S.M.P.E. PROJECTION GROUP CITES SEATING NEEDS

The Projection Practice Committee of the S.M.P.E. has considered in great detail, and over a period of years, methods of increasing the enjoyment of theatre patrons in their viewing of the screen picture.

The Committee regards clear and unobstructed viewing of the screen as an essential and major factor in audience satisfaction. It disapproves of any form of auditorium design or seating arrangement which prevents the individual patrons from seeing all parts of the screen at all times, and regardless of the positions of other patrons. There are several degrees of obstruction of viewing the screen. Arranged in order of diminishing desirability, these are:

Grade 1. Clear vision regardless of positions of patrons one or more rows ahead.

Grade 2. Clear vision regardless of positions of patrons two or more rows ahead.

Grade 3. Partially obstructed vision under almost any conditions.

To reduce obstruction of viewing, there are several methods available including the following:

a. Staggering seats in successive rows (which may reduce the number of seats or cause "ragged" aisles).

b. Raising the level of each row of seats relative to those before them (which may lead to an impractical amount of rise in some theatres from front to back).

c. Adopting a suitable combination of fall and rise of successive rows of seats from front to back (which method requires further study in practice on a wider scale under various conditions).

One or more of the above available methods should be seriously considered by theatre architects. In no case does the Projection Practice Committee approve any seating arrangement falling appreciably below Grade 1 above—that is, the Committee disapproves any noticeable and unpleasant obstruction of the screen view of one patron by other normally-seated patrons no matter where located.

SOUND TRACK DUBBING OUT IN WEST COAST STUDIOS

There will be no further dubbing of sound tracks or canned music used in studios. Representatives of the A. F. of M. and producers have agreed to this

and a contract has been signed. All types of pictures will be affected except news reels.

Principal clause in contract will provide for complete elimination of use of a sound track except to accompany the picture for which the music was prepared, performed and or recorded, identification of picture to be registered at time of recording.

It is estimated that contract will provide $1,000,000 more in pay to musicians annually.

ACT TO BAR BAD PRINTS IN CANADIAN THEATRES

Canadian exhibitors will act in regard to complaints received by exhibitors that they are receiving bad prints, it is understood. One exhibitor reported he found 122 patches in one print, alone, and that the same week he received a picture that had no ending.

Exhibitors are being supplied with a triplicate form, on which projectionists note in detail the condition of each print as received. One copy is to be kept by the theatre, one forwarded to the exchange and one sent to the office of the exhibitors' association so that the secretary can collect this evidence for consideration and association action.

FESSLER JOINS MOTIOGRAPH

Frank D. Fessler, development engineer for Erpi since 1929, has assumed a similar post with Motiograph, Inc. While with Erpi Fessler had charge of such projects as the improvement of manufacturing methods and design of theatre apparatus. Previously he was engaged in radio transmitter engineering work for Westinghouse.

ANOTHER CHAIN TO ALTEC

Altec Service Corp. will service the entire Switow Theatre Circuit extending throughout Kentucky and Indiana, under a recently concluded agreement.

OBSERVE DEVRY ANNIVERSARY

Herman A. DeVry, well-known manufacturer of motion picture equipment. was tendered a testimonial banquet recently in honor of his 25 years of service in the motion picture field. The event was held in connection with the meeting of the National Conference on Visual Education, founded 12 years ago by Mr. DeVry.

EDUCATIONAL REQUISITES OF THE ELECTRONIC INDUSTRY

(*Continued from page* 20)

non-prepared subjects, the student will find it advantageous to choose as many as possible from the following: 1. Free-hand drawing; 2. Mechanical drawing; 3. Shop practice; 4. Music appreciation, and 5. Touch-typing.

Even with such preparation there is considerable mortality among entered students in engineering schools, and although some of this can be traced to lack of adaptability to new environment, no small proportion is due to lack of ability to make the transition from high school to engineering school types of studies. The new student in engineering is called upon to utilize all of his previously acquired knowledge of mathematics and the sciences to solve

the many problems in his new studies.

Since engineering school subjects are taught largely from a quantitative rather than a qualitative viewpoint, the new student is required to exercise transfer of training* never before attempted. It is in the prevention of excessive mortality in making this transition that the Junior College serves a most important purpose.

Furthermore, a great many young boys are graduating today from secondary schools at the age of seventeen. Such students lack the maturity of the student who is nineteen or twenty years of age, and as a result, usually make a poorer showing scholastically in engineering than the older boy. For such students the Junior College provides an intermediate training that is not only of great benefit in his future school work, but also permits the student to gain two years of age without the time being wasted.

Another important point is that scientific advances have so crowded the curriculum of the professional technical school, that more and more of the so-called cultural subjects have been crowded out. It is not that these subjects are considered of no benefit to the engineer; to the contrary, it is doubtful if any single profession has become as conscious of the necessity of a satisfactory cultural background as engineering.

● Anent Cultural Subjects

However, as previously mentioned, the great range of scientific education which the engineer must acquire has made the inclusion of any great number of cultural subjects an impossibility. For this reason the professional technical school has come to depend more and more upon some sort of pre-engineering course which includes these cultural subjects. It is in conjunction with this phase of pre-engineering training that the Junior College finds one of the greatest fields of usefulness. With over five hundred such organizations already in existence in the United States, and more being added each year, it is often possible for the student to obtain his pre-engineering training without leaving his home town.

Personality and ability to get along with fellow workers are two of an engineer's most essential attributes, and nowhere can these qualities be better developed than in the Junior College where the instructors are dealing with relatively small groups.

Since a considerable amount of an engineer's work involves the preparation and delivery of instructions and reports, next in importance is facility in the use of the English language, *viz.* ability to express oneself in a clear, concise, and accurate manner both orally and in writing. Further, the engineer frequently develops equipment or makes scientific discoveries which are considered of such importance that he is asked to give a talk before an engineering society on his latest work. This involves appearing before an audience of several hundred people and making a public speech. It is in this respect that engineers as a group have had some difficulty. In this regard the pre-engineering training can make a most valuable contribution by giving considerable work in public speaking in their English courses.

Many engineers also fail to realize

*By transfer of training is meant the ability to apply knowledge gained in one subject, such as mathematics, to the solution of problems in another subject, such as physics.

that in a business sense they are representatives of their company and that to people with whom they have business dealings, they are the company. Many situations have arisen where engineers either through their personal mannerisms and inability to get along with other people have discredited both themselves and the company which employed them. It is important that the

Table 1.—Pre-Engineering

First Semester	Second Semester
First Year	
English Composition	Advanced Comp.
Vocational Sociology	Vocational Sociology
Solid Geometry	Analytical Geometry
College Algebra	Trigonometry
Mechanical Drawing	Mechanical Drawing
Chemistry	Chemistry
Physical Education	Physical Education
Engineering Fundamentals	Engineering Fundamentals
Second Year	
First Semester	*Second Semester*
English Literature	English Literature
Dif. Calculus	Int. Calculus
U. S. History	U. S. History
Comparative Government	U. S. Government
	Physics
Physics	Descriptive Geometry
Engineering Fundamentals	Engineering Fundamentals

engineer be trained to solve personality problems as well as technical problems, and it is here that the Junior College cultural background proves most useful.

The student contemplating an engineering career will therefore do well to expend the same time and care in planning his pre-engineering training that he does in arranging his technical school program. A typical pre-engineering curriculum available in most of the Junior Colleges throughout the country is shown in Table 1.

SHOW BUSINESS IN ENGLAND: TECHNICAL, CRAFT ASPECTS

(*Continued from page* 16)

suffice in ordinary resistance systems, to fill the wall of the projection room.

The principle of this device is very simple. Each slider moves an iron core in a saturated choke and so controls the grid voltage on a thyratron valve. In an adjoining room is a large bank of these valves, a section for each lighting circuit, each section having two thyratrons and a rectifier supplying its own particular circuit.

Every effect associated with modern dimmer systems can be obtained, but the automatic control is particularly novel: instead of all the lights fading at the same rate, the different circuits are so timed that the lights start to dim at one end of the theatre and, for instance, the coves down the side walls fade out progressively. On a duplicate control panel installed on the stage there is a pre-set board, enabling any effects to be pre-set and brought in when required. The total value of the circuits controlled is 180 kw., in 66 circuits. (I. P. Note: This system was first introduced in America, the Earl Carroll Theatre on Broadway, N. Y.

City, being the first installation in 1930.) . . .

Television is becoming increasingly popular, with 5,000 sets in operation in the London area alone. The B. B. C. broadcasts three shows a day, 11 a.m.-12 noon; 3 p.m.-4 p.m., and 9 p.m. to 10 p.m. Vision is on 6.67 meters and the sound on 7.23 meters. The range is limited to around 50 miles. The programs consist mostly of news reels, acts, orchestras, lectures and playlets.

● Television in England

I visted Selfridge's Television Theatre and saw the following sets demonstrated: "His Masters Voice," Baird, Marconi, Halcyon and Cossor. They come in three models: straight television, all-wave radio and television, and electric victrola all-wave radio and television. Prices range from $200 to $600. In some makes one views the picture direct, and in others via a mirror. The size of picture varies from 8 x 6 to 10½ x 14, meaning inches of course. They all use the cathode ray tube from 9 to 15 in. in size. The reception of both sound and picture on all the sets I saw was remarkably good. The color tone of the different pictures varied somewhat, and one could notice a certain amount of distortion when several sets were working side by side simultaneously.

However, while it was interesting to see the progress made in television, a lot is still left to be desired and vast improvements will have to be made before television could begin to compete with the present sound motion picture . . .

The amusement world as a whole has become quite Americanized due mostly to talking pictures and tourists. However, they still retain many customs that we do not have over here. Smoking is allowed in practically all theatres, cigarettes and chocolates being sold and tea and ice cream served during the performance! All the larger theatres have either a cafe or bar, or both, and some even have a dance hall as well. All theatres have a price range, some as many as five, according to seating location. Employes all work far more hours per week for a lot less than the prevailing wages in theatres in America.

ACADEMY THEATRE SOUND EQUIPMENT PROPOSALS

(Continued from page 15)

to cover a vertical angle of 65°.

Rear Radiation: Past practice indicates the extreme need for reducing rear radiation from loud-speakers, and it is desirable that loud-speakers be manufactured which have a minimum of rear radiation.

Dividing Networks: The dividing network shall be designed to have an attenuation of approximately 12 db per octave.

Part V—Servicing Networks

Meters and Circuit Arrangements: Accessible terminals for a volume indicator and a switch for the substitution of a resistance equivalent to the loud-speaker load should be provided at the output of the power amplifier in order that the electrical characteristic may be conveniently measured. It is further recommended that a meter or its equivalent be made available on the various vacuum tubes, as it is difficult to service equipment which does not have adequate metering facilities.

Wear: The design of the sound head

should be such that items subject to wear are easily removable; for instance, provision should be made for the easy replacement of the felt pads on the pad roller.

Maintenance: All equipment and wiring should be available for inspection and maintenance. For instance, an accessible method for checking the photocell transformer and wiring without disturbing the rotary stabilizer, if used, should be provided.

Measurement: Any part of the equipment which is subject to measurement should be designed so that such measurement may be conveniently made.

Physical Position of Equipment: From a servicing standpoint, it is desirable to mount as much of the projection equipment as is practicable in the projection room, such as the field supply and dividing networks for loudspeakers.

Part VI—Studio and Preview Theatre Requirements

In reproducing equipment used in preview theatres and in the studios, certain requirements are necessary in addition to those of the average theatre. These additional requirements are listed below and are given here in order that the manufacturer, when designing and planning new equipment, may make provision for them. It is essential that studio sound departments review their product in rooms having equipment which is typical of that in theatres, in order that they may evaluate that product in terms of the average theatre equipment.

Double Film Attachments: Sound heads should be designed so that it is not difficult to provide either single-phase or interlocked motors and space should be provided for the mounting of double film attachments capable of handling 1000′ reels.

Auditorium Volume Control in Link Circuits: A link circuit of 500 ohms impedance should be provided in the voltage amplifier for auditorium volume control. This facility should be available without raising the hum level, and for this reason it is recommended that this volume control be at a position approximately 40 db above photocell level.

It is further specified that the power capacity of the amplifier system must not be reduced when a maximum of 20 db attenuation is used in the auditorium control. In order to avoid possibilities of introducing distortion when inserting equipment in link circuits, it is very desirable to have a constant impedance in both directions throughout the frequency range used.

Pleased Patrons *and* Showmen *asked...*

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PROJECTIONIST

AUGUST 1938

VOLUME 13 • NUMBER 8

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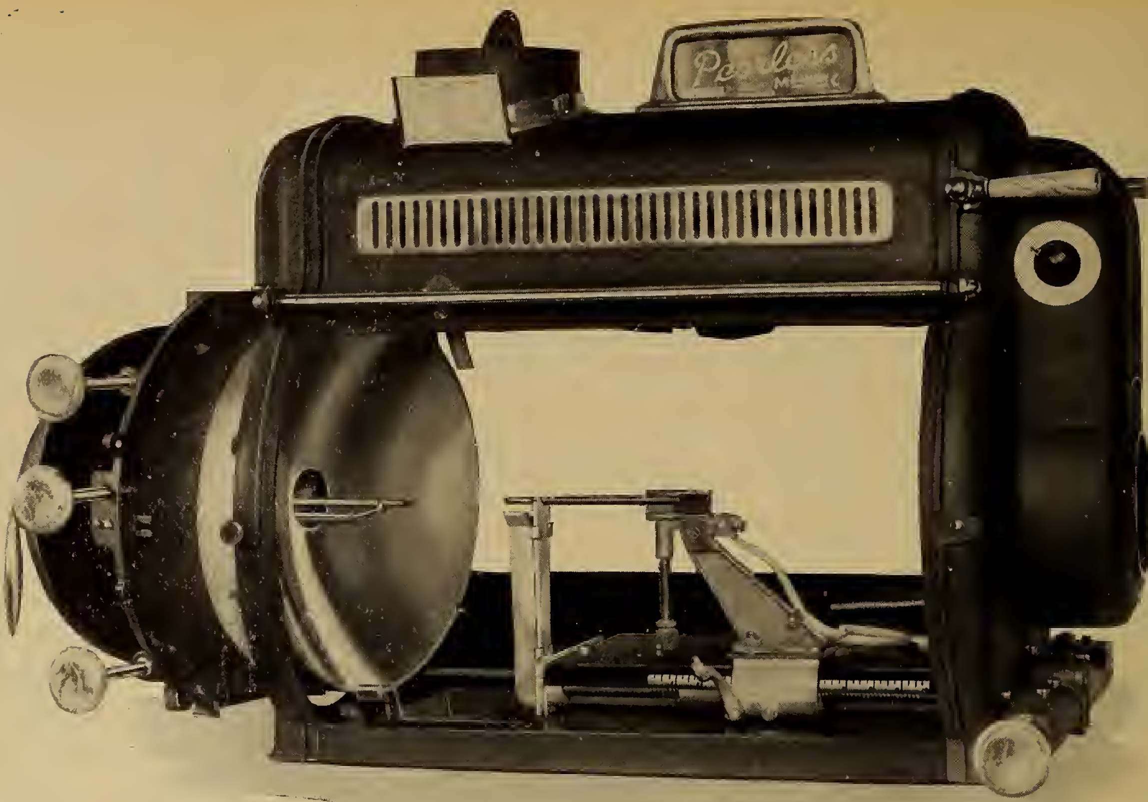
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International PROJECTIONIST

With Which is Combined PROJECTION ENGINEERING

Edited by James J. Finn

Volume 13 AUGUST 1938 *Number 8*

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Monthly Chat

THINGS projection also move in cycles, it seems. One month it's television that excites the boys' curiosity; the next it's push-pull reproduction; then it's a flurry of homemade devices designed to cheat the manufacturers and supply dealers, and so on. Currently some of the boys are excited about ways and means for measuring film programs. Why, we just don't know. Of course, the affluent Loew Theatres actually buy the boys counters at $37.50 each, but our concern lies with the run-of-the-mill houses where $37.50 is frequently the day's take.

Let's see: there's the Cinetymer, all kinds of rulers and similar gadgets, and now comes the engaging J. A. Cook, of St. Louis (a frequent contributor to these columns) who insists that his system for film-measuring really is IT. (We're trying it out right now; results later.) Mr. Cook says that exchange footage marks mean nothing to any sensible projectionist. We agree; although the exchanges insist that they replace all deletion of four or more frames. Yeh! The Cinetymer people and Mr. Cook both claim for their respective devices an accuracy within 2%, which is close enough. These worthies also assert that Mrs. Google no less than the salesman who tires easily after 1 p. m. are entitled to know if the feature hits the screen at 3:02 p. m. or at 3:29, and that many theatres want this info both for phone callers and for lobby display.

Our idea is that immediately following the first complete performance the theatre knows exactly how long each unit requires and also the running time overall. A house has so much film, bought and paid for, and even if they want to cut the last show to avoid overtime payment, there remains ample time to adjust the program after the first showing for the day.

This furore about film measuring devices leaves us rather clammy, particularly in view of the known proclivities of projectionists to cast adrift such aids to perfection as carbon savers and footage counters. Yes?

WHY the installation in N. Y. and L. A. theatres of special visual and sound projection equipment for the first showings of such films as *Marie Antoinette?* The job will never look or sound as good as that again; but it might make unhappy a number of trusting exhibitors.

RECOMMENDED strongly to all readers is the article herein anent projection room safety by T. P. Hover, who certainly knows his stuff. We believe that this is the most comprehensive and understandable job ever done on this topic and one that may prevent serious accidents (if not worse) and save Mr. Projectionist many heartaches and no little money.

INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 8

AUGUST 1938

Some Common Sources of Noise in Theatre Sound Systems

By *AARON NADELL*

III.

COMPLETELY distortionless reproduction would copy the original sound with absolute fidelity. The equipment for doing that has yet to be invented; nevertheless, the best modern apparatus can hold distortion within limits so narrow that listeners consider the reproduced sound "natural" and enjoyable. The necessarily rigid limits are, however, easily exceeded as a result of very small mistakes in either operation or maintenance, reducing the pleasure of the audience or, perhaps, destroying it entirely.

Most projectionists are aware that there are several types of distortion, each of which must be treated individually. An uncritical ear often finds difficulty in distinguishing one from the other, noting merely that sound is "not good". But trouble-shooting is made a great deal easier if a particular form of distortion can be identified quickly, thus reducing the possible causes from an almost infinite number to perhaps half a dozen, or even less. Consequently, it is worth while to learn what different kinds of distortion sound like; this can be done by paying careful attention to them when they appear accidentally, and more quickly by intentionally producing them at times when no audience is present.

Forms of Distortion

At least five entirely different kinds of distortion are of direct interest to the projectionist, being more or less under his control. In distinguishing them it is necessary to call attention to some small confusion of existing nomenclature, since at present the same trouble is sometimes called by two different names, while occasionally the same name is given to more than one kind of trouble.

The most common fault, and probably best known to practical projectionists, is that in which the apparatus discriminates for or against certain groups of frequencies. This is sometimes termed *frequency distortion,* for obvious reasons; but it is also known as *amplitude distortion,* meaning that all frequencies are not reproduced at the same proportionate amplitude or volume. The term *frequency distortion* will be used in this discussion.

Frequency distortion is also the term applied to an entirely different condition, one in which the apparatus generates spurious frequencies not present in the original sound and adds them to the final output. Since these frequencies are always harmonics [arithmetical multiples] of the original tones, the condition is likewise described as *harmonic distortion,* and that name will be preferred here.

A third and universal fault can be conveniently designated *volume distortion,* meaning that, regardless of frequency, the reproduced ratio between loud sounds and weak sounds is not as great as in the original.

Phase distortion is a condition relating to timing. If, in the studio, two

sounds are created simultaneously, then in the theatre they should reach the ears of the listeners simultaneously. For reasons to be discussed subsequently, this is not always the case, but one of the sounds arrives a fraction of a second

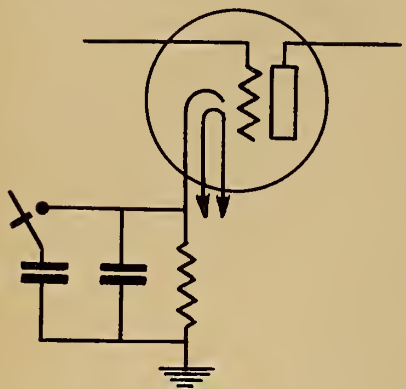

FIGURE 1

after the other; or, alternatively, neither may arrive, the phase difference being 180 degrees and the two sounds cancelling each other.

A fifth classification often alluded to as *frequency modulation*, is more familiarly known to projectionists as *flutter*.

All of these conditions have the effect of making sound seem unnatural, unpleasant, or both.

● Distinguishing Distortion

These five different ways in which sound seems unnatural can be distinguished by attentive listening. This check is preferably applied in the auditorium, not in the projection room. Monitor speakers and headphones introduce frequency distortion of their own, and are utterly unreliable in dealing with that type of difficulty, except in the most extreme cases. They may also fail to a considerable extent to reproduce harmonic and volume distortion as the audience hears them. They miss entirely some types of phase distortion. Lastly, they operate in competition with unavoidable projection room noises, with the result that the fainter noises may be masked and wholly inaudible.

When listening in the auditorium, frequency distortion can be recognized at once, provided one knows for what to look. The most common fault of this nature is a loss of high-frequency sounds. Those frequencies are conspicuous in *s* and *f*, *sh* and *ch* of human speech, called the sibilants. A slurring of sibilants in reproduction is sure evidence that the "highs" have been lost. They may have been lost in the recording, however, or perhaps are absent only in certain parts of the auditorium, or may be missing only in the case of one projector and present when the other is used. These points are to be checked before further work is done.

The higher frequencies also, as is generally known, impart sparkle and life; beware of sound that seems too "mellow": the "highs" may be missing. Lastly the highs make it possible to distinguish the instruments of an orchestra from each other; if this cannot be done, they are probably missing.

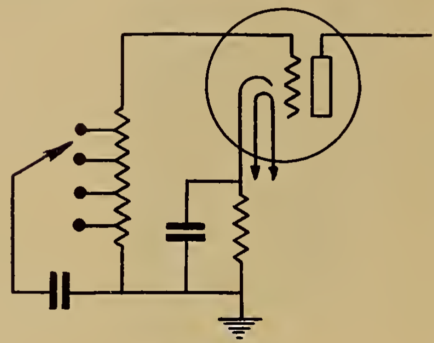

FIGURE 2

At the other end of the scale "lows" may be lacking, but this condition is much more difficult to distinguish, since if their harmonics are present the ear will apparently hear the fundamental also, although the full depth and richness of the sound will be lost.

Further, any middle or extreme group of frequencies may be either missing or accentuated. A great many different conditions are possible, too many to describe here in detail. Fortunately, in this particular form of difficulty, a simple instrumental check is available and known to most projectionists as a "gain run".

The gain run uses either an audio frequency oscillator or a frequency film, and an output meter which is essentially an a.c. voltmeter calibrated in decibels. Different sound frequencies are put into the apparatus either at equal volume or at known volume differences; their outputs as measured should be proportional. The nature and extent of any discrimination is revealed at once. Where it exists the oscillator may be used to repeat the test on each separate component of the system, taken alone, thus revealing the location of the fault and facilitating the work of finding it.

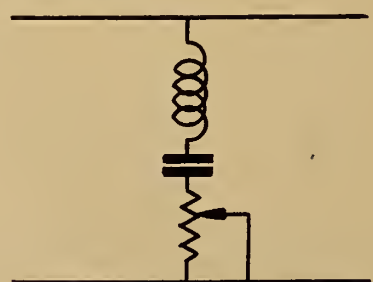

FIGURE 3

These tests do not eliminate the need for checking by ear, since they do not include the loud speakers or the auditorium acoustics, either of which can produce results just as unpleasant to the audience as a defective amplifier. Speakers and acoustics need investigation, if the ear shows frequency distortion and the output meter does not.

● Tests for Distortion

One way to become familiar with the sound of frequency distortion is by deliberate misadjustment of the tone control devices with which many systems are equipped—when no audience is in the house, of course. Figs. 1 to 3, inclusive, illustrate a few of the more common forms of control devices used in theatre systems. Fig. 4 is one of many types of fixed tone controls, or filters, or equalizers, which, while not variable, can often be switched temporarily out of circuit. Another way is to deliberately create, in the absence of an audience, one of the accidental conditions described hereafter which result in frequency discrimination.

Harmonic distortion is more difficult to recognize. It is usually characterized by the presence of excessive volume at the higher frequencies, since the harmonics, of course, are higher in tone than their respective fundamentals. But this difference is not always enough to be recognized easily, and may be further masked by inability of the same system to reproduce "highs" at proper volume. If the system uses reverse feedback or other harmonic "equalizer" circuits, intentional misadjustment of these can be made to produce a large degree of harmonic distortion.

A description most readers will recognize instantly is to say that harmonic distortion simulates the tone quality of a poorly designed radio. Grounding the grid of one tube of the push-pull output stage will produce recognizeable harmonic distortion, but this procedure demands caution, since it imposes a one-sided load on the power pack that not all amplifiers can withstand; consequently resort to it should be confined to equipment known to be able to take the strain temporarily without risk of damage. It is reasonably safe with nearly all pure Class A amplifiers.

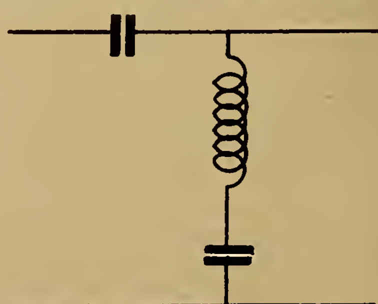

FIGURE 4

Volume distortion means that no sound system can produce weak sounds at their original intensity without entering into the noise level, and none can

as yet produce very loud sounds with their original intensity. The full volume range still cannot be duplicated. But the best modern equipments and recordings produce a good illusion of it. Failure in this respect is easily recognized by the presence of high noise level, which makes it necessary to raise the volume control for whispers and other weak sounds, and by strong distortion in tone quality at loud sounds. This last is largely harmonic distortion, but because of the high volume does not sound quite the same as harmonic distortion at lower volume levels—that is, the ear sometimes has difficulty in recognizing the two conditions as being the same, hence raising the gain control is not the best way of learning to recognize excessive harmonic distortion at normal volume.

Phase distortion is also a condition always present in the theatre: two frequencies which originated simultaneously in the studio do not reach the theatre audience simultaneously. However, a time difference amounting to only a few thousandths of a second is not heard. More serious phase distortion is noticeable chiefly at the beginning of a transient sound, and is easily recognized. It may be encountered in some areas of the auditorium as a result of incorrect speaker placement, or may originate in an amplifier as a consequence of improper repairs.

Frequency modulation or flutter results from irregular film motion. Consider a simple variable-area track in which 1,000 dark peaks pass through the exciting light in 1 second, producing a thousand-cycle tone. If the film speed varies—say, plus or minus 2 per cent—the sound heard will shift between 980 and 1020 cycles, or a full half-tone in each direction. Singers and violinists often intentionally produce a similar effect, seldom, however, as great in extent. The effect, artistically controlled, may add to the pleasure of music; mechanical in origin and uncontrollable, it induces displeasure, and may even make sound difficult of understanding. The piano is among those instruments that cannot produce this effect: its sound is distorted and rendered unrecognizable when flutter appears as a result of unsteady film motion. Hence piano recordings are used extensively to reveal even small traces of this condition.

Flutter can readily be produced for identification purposes by almost any small slip-clutch type of interference with the film in the sound head, and more accurately by deliberate improper threading. Thus in double-sprocket heads the film may be run directly into the lower magazine from the upper of the two sound sprockets, skipping the lower one. In rotary-drum type heads however, even this method may not produce sufficient flutter to be recognizable when the equipment is in good condition. A better method may be to skip the lower projector sprocket, running into the sound head directly from the lower intermittent loop. These tricks, of course, must be applied in accordance with the type of equipment used, and with suitable precautions against tearing good film.

Treatment of Distortion

The most common cause of frequency discrimination is simply improper focus of the exciting light, which cuts down the high-frequency response. In modern equipments another form of this trouble arises out of loss of volume in either the low- or the high-frequency amplifier, when these are separate; from inadequate field excitation of either low- or high-frequency speaker units, or incorrect setting of the loud speaker dividing network. Frequency discrimination is also a common manifestation of deficient auditorium acoustics. It may be created by failure of a number of sound parts, such as open-circuiting or short-circuiting, according to conditions, of the condensers shown in Figs. 1 to 4. Accidental misadjustment of such circuits as shown in those figures occasionally occurs, and should always be suspected.

The best procedure is to try, either by listening tests or preferably by volume readings as previously described, to localize the source of trouble. However, the very common causes, as just mentioned, should be afforded attention before this is done, and the exciting lamp focus, above all, should be the prime suspect. In cases of frequency distortion traced to a particular amplifier or other unit, inspection of the schematic will reveal which parts could, through short-circuit, open-circuit or other flaw, give rise to the difficulty; these are then checked individually. Even where the trouble is not found, it can often be compensated for temporarily by proper adjustment of Figs. 1 to 4, or by altering the volume ratios of the low- and high-frequency amplifiers, producing a satisfactory show until time allows more detailed investigation.

It is unnecessary to add that such adjustments cannot be considered a permanent cure, since the real cause may be only a symptom of further trouble impending, possibly a breakdown. Thorough investigation, until the true condition has been completely uncovered, is always imperative.

Harmonic distortion usually results from tube overload, but may also be created by failure of provisions for its suppression built into the equipment. The most common of these is in push-pull amplification, and weakening of one tube of a push-pull pair will always increase this form of distortion to some extent. Where one tube is seriously weakened, the resulting tonal fault may be clearly audible. Modern amplifiers using reverse feedback may produce very marked harmonic distortion as a result of failure of that circuit. In this case there will nearly always be a corresponding increase in volume that indicates immediately the true condition.

Harmonic distortion may also be increased by improper use of the gain controls, as in the case of Fig. 5. Referring to that figure, assume that the gain control of the voltage amplifier is set too low, as a result of which the wall volume control is run too high. This condition may overload tube V-1 of the voltage amplifier, and thus introduce unnecessary distortion. The voltage amplifier potentiometer should be so set that the wall controls normally are in somewhat lower than central position, as much lower as they can be brought without depriving the projectionist of complete flexibility in making adjustments.

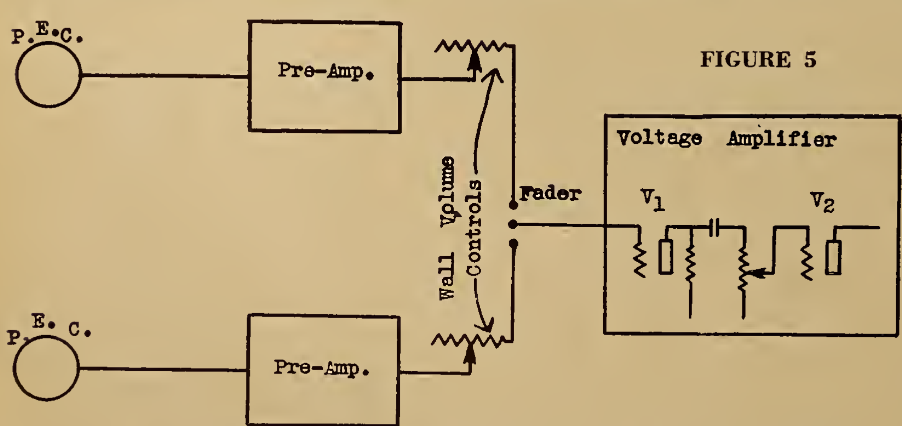

FIGURE 5

Volume, Phase Distortion

Volume distortion can also result from improper use of Fig. 5 controls. Thus, if the wall potentiometers are set too high, V-1 tube may be unable to respond fully to peaks of high volume. A more

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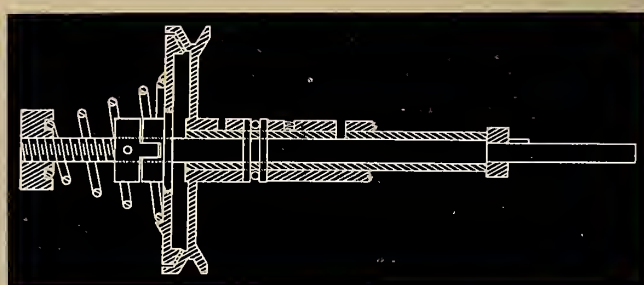


A study of this simplified sectional sketch will reveal the design superiority of the Motiograph Cone Friction Take-Up.

MOTIOGRAPH Inc., Chicago, U.S.A. IN SOUND PROJECTION *"The Standard of the World"*

common cause of restricted volume range is excessive noise (I. P. for July, 1938, p. 7), which makes it necessary to run sound too near the upper volume limit. Still more common, even today, is the practice of theatre managers in keeping sound too loud. This practice brings the normal level of sound too close to the upper limit and again restricts the extent of volume change available.

Volume limitations are also imposed by inability of the equipment to function as it should at high levels, requiring the projectionist to pull down the gain, although the studio has recorded and intended maximum sound. Old tubes may be responsible, or low line voltage, or misadjustment of Fig. 5, or insufficient speaker field excitation—any cause that introduces unnecessary loss at some point and thus necessitates at other points more amplification than a given tube can handle.

Phase distortion is not a very common theatre condition, but it sometimes appears when amplifier repairs have been made hastily or improperly, substituting parts not having the same ratings as those they replace. This fault is now more common than formerly, since many parts are now rated by color-code only, and the colors may be difficult to distinguish when the old resistor or condenser is covered with dirt and oil.

Another and entirely different trouble, sometimes called phase distortion, is usually of short duration. When a speaker unit is replaced and the wires returned to the wrong binding posts, the unit may be out of phase with the others, producing marked dead spots; these are easily removed by reversing the connections.

Flutter is a more complex trouble, with which most projectionists, fortunately, are now reasonably familiar—also, fortunately, one that has been minimized in equipments. Wear will still produce it, however, as will a defective take-up, strongly irregular in its action; a badly worn projector head, or any other serious fault in film or equipment that defeats the best efforts of even a rotary-drum type scanner. Flutter sometimes is caused by presence of oil on the drum surface.

HURLEY SCREEN SALES NOW HANDLED BY FOREST

The entire sales and distribution of Hurley Screens has been taken over by Forest Mfg. Corp., of Belleville, N. J., makers of the Forest magnesium-copper sulphide rectifiers. New price lists, samples, catalogs and other selling aids will go forward to dealers immediately. Forest promises that the "economies necessarily resulting from this move" will be used to improve the quality of Hurley Screens "at a price permitting a just margin of profit" to the dealer.

Notes on Recent Developments in Sound-Film Reproduction

By *M. J. YAHR*

COMMERCIAL ENGINEER, PHOTOPHONE DIVISION, RCA MFG. CO., INC.

These excerpts from an address delivered by the author at a recent convention of Fox Inter-Mountain Theatres managers covers in a general way the development of sound recording and reproduction from its inception down to the present, including the various improvements made which contributed signally to a more realistic presentation of the picture in theatres.

TEN years ago the movies were given a voice. At first the sounds which it made were raucous and unintelligible, but gradually at first and more rapidly later these noises took on an understandable nature. Today, a motion picture with unintelligible dialogue is as objectionable to the average theatre-goer as insufficient light on the screen with resultant poor definition. The two sensations of sight and hearing complement each other.

During the transition of sound from microphone to loudspeaker, innumerable problems are encountered and must be overcome. For example, the speed of the film past the scanning light in both the recorder and soundhead must be absolutely constant. Failure to maintain a constant speed results in the objectionable phenomenon known as "wows." This is readily recognized as a wavering in the sound. In prolonged musical passages the pitch changes back and forth. Obviously, it is of prime importance that the recorder be equipped with a device to maintain constant speed, since if any "wows" are recorded on the film, they will be reproduced in theatres regardless of the efficiency of the reproducer system. In fact, the more nearly constant the speed of the soundhead, the more noticeable these waverings will seem by contrast with the well-recorded sections.

The Rotary Stabilizer

After several years of intensive work, it was found that it was possible to isolate the sound recording drum from the other driving elements, such as gears and shafts, and thus remove one of the most prolific sources of "wows." The sound drum in modern recorders is driven by what is known as a "magnetic drive," which has thus far proven the best possible method for this purpose. It consists, essentially, of a drum around which the film is wrapped. The drum is fastened to a shaft which rotates in a highly-polished bronze bushing of extremely close tolerances. At the other end of the shaft a copper ring is fastened and extends into a rotating magnetic field. Thus, there is no mechanical connection between this drum and the other driving elements of the system.

Because of the relatively high cost of such an arrangement, it has not been possible to incorporate it in soundheads. Originally, flywheels of various shapes and sizes, to which all kinds of springs were attached, were resorted to in order to achieve a reasonably constant drive. None of these have proven entirely acceptable, however, since they were critical of adjustment. If maladjusted in one direction, the filtering action of the springs disappeared and the arrangement approached a direct drive. If in the other direction, the arrangement tended to over-compensate for speed variations, resulting in larger variations.

Several years ago, an entirely new type of drive, now familiarly known as the Rotary Stabilizer, was developed in the RCA laboratories. With minor modifications and refinements, this mechanism has been accepted by engineer and layman alike as the most acceptable method to assure constant speed in reproducers. In results, it closely approaches the magnetic drive—so closely in fact that on smaller film-recording equipments where price and portability are primary requirements, it is used instead of the magnetic drive. Briefly, the device consists of a drum attached rigidly to a shaft to which is fastened a hermetically-sealed case filled with oil. Inside this case is mounted a freely-rotating flywheel which is set in motion by the action of the oil. In a well designed rotary stabilizer, it has been found that the "wow" content, when measured with accurate instruments, is much lower than is perceptible to the human ear.

Since the amplifier is the second link in both the recording and reproducing chain, we shall consider their design and fabrication. The ideal sound system is one in which the reproduced sound is an exact duplicate of the sound originating in the studio. It is well-known that there is a decided difference in the sound of the middle C when played on

(Continued on page 27)

The Theory of Commutation

By ENGINEERING DEPARTMENT, NATIONAL CARBON COMPANY

Here is the first two articles which, through the exposition of clearly defined fundamentals, constitute a simple and logical presentation of a somewhat complicated subject. Motors and generators are used quite extensively in and about the projection room, and these articles will convey to the reader a good idea of what goes on inside these machines.

THE subject of commutation is considered by many engineers to be one of the most intricate in the science of electrical engineering. It involves a number of factors the relationship of which is difficult to establish experimentally, and equally difficult to analyze, except on a basis of approximation, by mathematical means. It is, therefore, impossible to attempt a detailed treatment of this subject in all its phases within the limits of a brief discussion. Some of the elementary principles involved will be presented, however, in order to give an insight into the functions the brush is called upon to perform.

Relative Directions of Motion, Flux and Current

Consider first the method by which a current of electricity is generated. Assume the conductor, illustrated in Fig. 1, to be moved downward past the poles of a magnet, cutting the lines of magnetic force. An electromotive force (voltage) will be induced in the conductor by this action. If the ends of the conductor are connected to some external circuit, such as the galvanometer (G) shown in the illustration, current will flow in the circuit so formed. The direction of this E.M.F. and current will bear a definite relation to the direction of the magnetic flux and of the movement of the conductor.

As it passes the north pole of the magnet in the direction indicated by the vertical arrow, the direction of E.M.F. will be that indicated by the arrow on the conductor. As the conductor is carried on past the south pole of the magnet, the direction of E.M.F. reverses, as will be indicated by a reversal of a galvanometer needle. Reversing the direction of either motion of flux reverses the direction of the E.M.F. generated in the conductor. Reversal of both motion and flux leaves the direction of the E.M.F. unchanged.

A simple method of determining the direction of the induced E.M.F., when the direction of magnetic flux and motion are known, is as follows: point the index finger of the right hand in the direction of the magnetic flux, assuming this direction to be from the "N" magnetic pole to the "S" pole through the intervening space; let the thumb be turned in the direction of motion; the second finger, extended perpendicular to the palm, will then indicate the direction of the induced E.M.F. This is illustrated in Fig. 2. By this rule the direction of either motion, magnetic flux or E.M.F., may be determined when two of these factors are known. This rule, for the right hand, applies only to generated E.M.F. In the case of a motor, the left hand should be used, and the extended second finger taken to indicate the direction of impressed E.M.F. or current.

There is another fundamental relationship between electric current and magnetic flux, which it is well to fix in mind at this point. A conductor bearing current creates in the medium surrounding it a circular magnetic field, the direction of which is clockwise when the current is flowing away from the observer, and counter-clockwise when the current is toward the observer.

This relation is indicated in Fig. 3, which shows the cross-section of two conductors and the surrounding fields. The plus sign and dot are the conventional symbols for indicating direction of current in the cross-section of a conductor in the respective directions noted in the figure.

From the foregoing it will be readily apparent that the relation of the direction of magnetic flux through the interior of a coil of wire to that of the current flowing in the wire is as shown in Fig. 4A. This relationship is indicated by grasping the coil in the right hand with the fingers pointing in the direction current is flowing in the wire. The extended thumb then indicates the direction of magnetic flux through the interior of the coil. This relationship, it may also be noted, is the same as the relative directions of travel and rotation in the case of a right-hand screw. Similar analogies apply to the relative directions of current and surrounding magnetic flux in the case of a single conductor, Fig. 4B.

The strength of the E.M.F. generated in a conductor varies directly with the time-rate at which it is cutting lines of magnetic force. It does not matter whether the motion be imparted to the conductor or to the magnetic flux. As long as there is relative motion between a conductor and lines of magnetic force, so that one cuts through the other, an E.M.F. will be generated in the conductor. If the pole of a magnet is thrust into the loop formed by bending a conductor until its ends meet, an E.M.F. will be generated momentarily and current will flow in the circuit of the conductor. When the magnet is

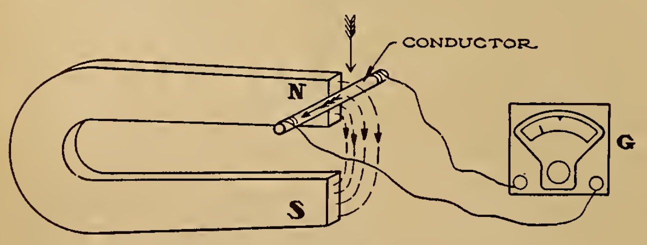


FIGURE 1
Illustration of electro-magnetic induction

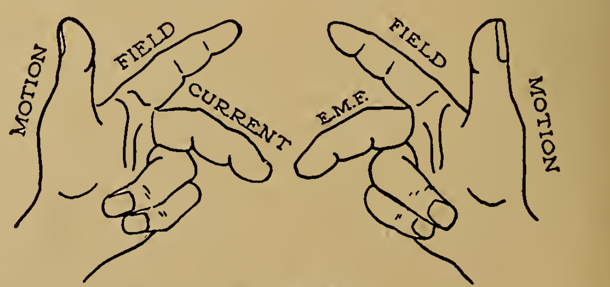


FIGURE 2
Left hand for motor; right hand for generator. Relative directions of current, field and motion

withdrawn the E.M.F. and current will be in the opposite direction.

From this it may be seen that changing the magnetic flux passing through a loop or coil of conducting material will produce the same effect as making the sides of the loop cut through a magnetic flux. In fact, the same action may be considered to take place.

When a magnetic flux is established through a loop, the lines of magnetic force completing the path of the mag-

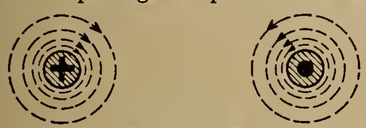


FIGURE 3

Current away from observer: surrounding flux clockwise

Current toward observer: flux counterclockwise

netic circuit may be considered to spread outward cutting through the sides of the loop. When the magnetic flux is reduced, a certain number of lines may be considered to collapse and cut through the sides of the loop in the opposite direction.

● Mechanical Generation of Electric Current

Having seen how an E.M.F. may be generated in an electrical conductor by movement through or change in strength of a magnetic field, and current made to flow by making the electrical circuit complete, let us now see how this principle is applied to the generation of electric current by mechanical means.

Consider a coil of wire revolved between two magnetic poles of opposite polarity, as illustrated in Fig. 5. For simplicity of drawing this has been illustrated as a single loop of wire, but the same principle will apply to a coil of any number of turns. From the foregoing it will be evident that an E.M.F. will be generated in the portions of this coil moving past the faces of the magnetic poles. As the movement of one side of the coil is up while the other is down and the direction of the magnetic flux is the same in both cases, the E.M.F. will be in opposite directions on opposite sides of the coil, that is, it will be cumulative in effect as regards the entire coil.

If the ends of this coil are connected to slip rings on the shaft by which it is rotated and these, through brushes, to an external circuit, a current will flow in this external circuit corresponding to the E.M.F. in the coil. This current will have a certain direction during half the revolution of the coil; but during the other half revolution, the direction of motion of the sides of the coil with respect to the pole faces will be reversed with consequent reversal of E.M.F. and of the current in the external circuit. This produces what is known as an *alternating current.*

For many uses it is desirable that current should flow in but one direction. This is known as *direct current,* as distinguished from alternating current. To accomplish this it is necessary that the current generated in the revolving coil be commutated, that is, the connection of the ends of the coil to the external circuit must be reversed twice during each cycle through which it passes. This result is accomplished by a commutator.

A commutator is essentially a pole-changing switch consisting of two or more segments to which the ends of the coils are connected. It is mounted on the same element of the machine as the coils in which the E.M.F. is generated. Usually this is the revolving element of the machine, and the unit, as a whole, is called the armature. The segments of the commutator are insulated from each other and from all other parts of the machine except the brushes which carry the current from the coils in which it is generated to the external circuit.

Fig. 6 illustrates the substitution of a commutator for the slip rings shown in Fig. 5 so that current of constant direction is supplied to the external circuit. Bearing in mind that the direction of current in a conductor passing a given pole face is always the same, it will be evident from a study of this

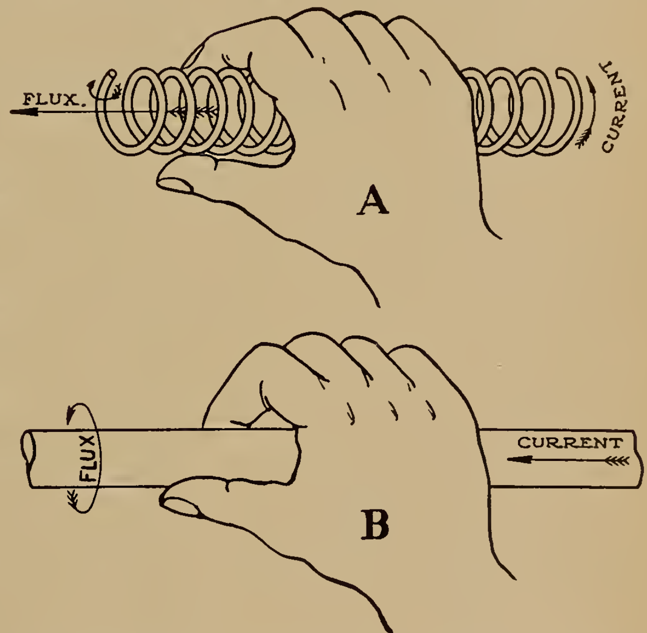


FIGURE 4

Relation of flux and current in conductor

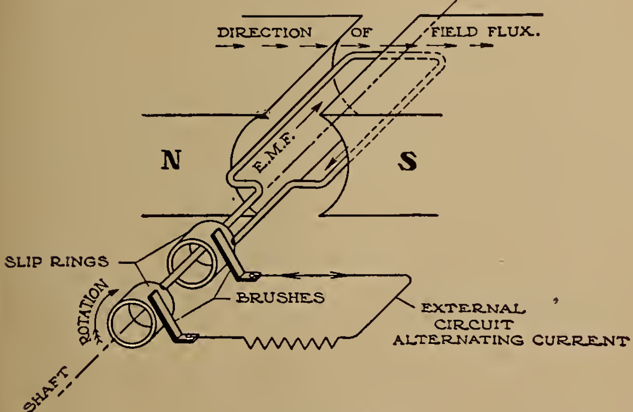


FIGURE 5

Generation of alternating current

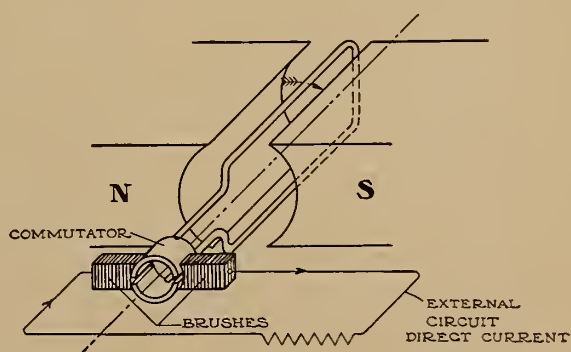


FIGURE 6

Generation of direct current

figure that current will always flow away from the armature through one brush and back into the armature through the other.

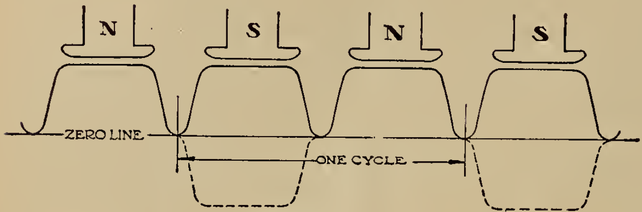


FIGURE 7

Form of E.M.F. curve generated in single coil and rectified by commutator. With slip rings, curve would follow dotted line on alternate half-cycles

FIGURE 8

E.M.F. curves for 2-coil armature with 4-segment commutator. Heavy line indicates terminal voltage

A machine for generating electric current by mechanical means in known as a generator. If used to generate alternating current, it is sometimes called an alternator. The part composed of the coils in which the E.M.F. is generated, the iron or steel core on which these coils are mounted and the commutator or slip rings to which their coils are connected, is called the armature.

The part made up of the magnetic poles with their component magnetic circuit of iron or steel is called the field magnet, or merely the field. In some small machines, known as magnetos, the field magnets are permanent magnets, but in most machines they are electro-magnets. The coils of wire on the field magnets, through which current is passed to establish a magnetic flux through the iron core, are called field windings or field coils.

A Simple Armature Winding and Commutator

In the preliminary discussion of the generation of E.M.F. in an armature revolving in a magnetic field we have considered, for the sake of simplicity, only a single loop or coil of wire connected to a commutator of two segments. It would be necessary for such a coil to contain a great many turns or to be driven at a very high frequency in order to obtain the E.M.F. needed for practical application. Furthermore, this E.M.F. and the current it would produce in the external circuit, while uniform in direction, would not be uniform in value but would fluctuate between zero and a maximum. Reproduced in the form of a curve, its appearance would be similar to Fig. 7, there being a wave for each magnetic pole one side of the coil passes in its revolution.

If the armature were made up of two coils, 90 electrical degrees from each other and connected to a commutator of four segments, each coil would produce an E.M.F. wave-form like that described above and 90 electrical degrees apart. This condition, and the time relation between the E.M.F. waves in the two coils, are illustrated in Fig. 8.

It is evident that there may be momentary dips in the terminal voltage but that voltage never reaches zero, as it does with a single coil. However, the circuits through the two coils being in multiple or parallel relation to each other, the maximum voltage at the terminals is no higher than that in the individual coils. Still further increase in the number of coils, with connections to the commutator segments so arranged as to place the coils in series with each other, increases both the value and the uniformity of the terminal voltage so that, with a multiplicity of coils, the terminal E.M.F. will have practically a constant value.

It is not advisable in this elementary analysis to enter into a discussion of the different types of armature winding. For the present purpose it will be sufficient to consider one simple type, an eight-coil, two-path, lap winding with an eight-segment commutator. This is illustrated in Fig. 9, the coils being shown in single turn and the brushes bearing on the interior of the commutator for the sake of simplicity in drawing.

The current generated by this armature returns from the external circuit through brush "N" and follows two paths through the armature to brush "P," where it again goes to the external circuit. These paths are N-F-16-9-E-14-7-D-12-5-C-P and N-G-13-4-H-15-6-A-1-8-B-P. Note that there are three coils in series in each path. The

direction of the current in each armature conductor is indicated, the cross indicating that the current flows in a direction away from the observer and the dot indicating a direction toward the observer.

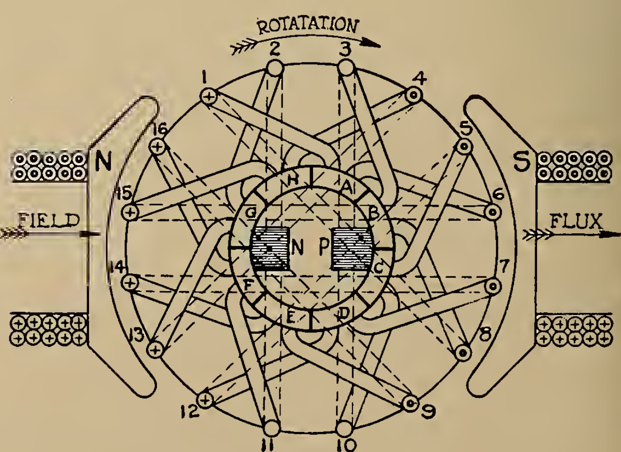
Conductors 5, 6, 7, 8, 13, 14, 15 and 16 are moving through the strong field under the poles and are generating the E.M.F. that is impressed on the external circuit. Conductors 1, 4, 9 and 12 are not cutting any flux except for a slight fringing field, and that due to the distcrtion of the main field. This distortion will be discussed later.

These conductors, however, are in series with those generating the E.M.F. and carry the same current. Coils B-3-10-C and G-2-11-F, short-circuited respectively by the brushes "P" and "N," are moving parallel to the main field and are not generating effective voltage nor carrying load current. They are the coils which are said to be undergoing commutation.

Consider coil B-3-10-C. When it was in the position now occupied by coil A-1-8-B, current was flowing in it in the direction indicated by the order of the symbols B-3-10-C. When it comes into the position now occupied by the coil D-12-5-C, current will be flowing in it in the direction of C-10-3-B. This reversal of current takes place while the commutator segments B and C are short-circuited by the brush "P," and is known as commutation.

FIGURE 9

Diagram of simple armature winding



(TO BE CONTINUED)

Foreword: More than twenty years ago, I collaborated with one of the pioneers of visual instruction, Dr. R. E. Offenhauer, of this city (Lima, Ohio), in a campaign to reduce the accidents among school students on their way to and from school. A perpetual program was devised, starting with the use of slides, later going to silent film and film slides, and, recently, to sound pictures.

Our program was sufficiently successful to gain the attention of the Superintendent of the Division of Safety and Hygiene, a branch of the Workmen's Compensation Commission. I find this commission one of the most interesting bodies of men I have ever met. Composed of outstanding personnel directors, safety engineers, physicians and surgeons, and assisted by hundreds of progressive industrial foremen, it is an organization whose record in the realm of safety and accident prevention is truly impressive.

In Ohio we are interested not only in compensating the workman who is injured in industry, but we are doing a creditable job of *preventing* that injury and in rooting out the professional chiselers and racketeers. Yes, even safety has its fakirs and racketeers.

Mary of the outstanding safety campaigns in which visual instruction has played a part were devised by members of our Local Union. I personally am under an I. A. contract with the Industrial Commission and supervise the visual instruction end of these safety campaigns. I believe that this is the only I. A. contract of its type in existence.

It seems unfortunate that the work of our inspectors is frequently hampered by employers and employees alike, who, when tipped off of a coming inspection, immediately dash around and attempt to get things in such a shape that they will pass inspection. Apparently they do not realize that safety inspections are intended to benefit not only the audience but also the worker and his welfare.

My personal opinion is that the safety and physical welfare of Union members is as much a part of the Union's business as proper working conditions and a living wage. When all I. A. locals recognize and concede this point, then the I. A. as a national body will have done something extraordinarily worth while. The large number of theatrical employees suffering from occupational diseases acquired in filthy, poorly lighted and ventilated projection rooms is a black page in the history of the labor movement, and the answer lies entirely with the Union which controls these employees.—T. P. H.

Accident Prevention—Not Insurance—Is Key to Projection Room Safety

By *THEODORE P. HOVER*

SECRETARY, I. A. T. S. E. LOCAL UNION 349, LIMA, OHIO

A PROJECTION room fire is usually so spectacular and impressive to those involved in it, that it leaves a life-long impression. The result is that the average beginner or apprentice has a definite ritual drummed into his consciousness, namely: cut off the light and turn off the motor; the next point may be to see that all port shutters have dropped, or to grab a fire extinguisher, or, as frequently stated, to jump out of the window.

The only case within my knowledge of a projectionist attempting to carry out his boast that "when the fire starts, I am on my way," occurred about two years ago when the man in question was assigned to an unfamiliar theatre. A short-circuit in the distributing panel at one side of the projection room caused a blinding flash and explosion. The projectionist made for a window in the back wall of the room and was half through it when he discovered, to his horror, that he was about seventy feet above the pavement with no fire escape or ladder available. (P. S.: He didn't jump.)

Due to the constant vigilance on the part of the projectionist, film fires and injuries resulting from them are slowly being reduced. However, assistance from both theatre owners and fire officials has been lacking; projectionists are largely on their own. Attention to the fire hazard has resulted in neglect to other important occupational dangers, which may be broadly classified as: (1) Mechanical (2) Electrical (3) Personal health and (4) Location and building.

It would be well to have a Union official establish a safety program for his particular Union. Every projectionist should have some knowledge of first-aid procedure and, more important, a thorough and practical knowledge of the Sheaffer prone-pressure method of artificial resuscitation. This system, as well as first-aid, can be learned through the cooperation of the Red Cross, a contact which every Local should make. A number of 16- and 35-mm. films are available, free, dealing with artificial resuscitation and first-aid.

● Safeguards on Mechanism

Few projectors are built with an eye to the safety of projectionists, and the fact that until recently sound equipment was a built-in or added-on proposition, has resulted in open gears, flywheels, and chains which can easily come in contact with the hands or elbows of projectionists, or more often, catch in their clothing. A short coat is emphatically much safer than the long smock which is frequently used. The idea that projectors are driven by a fractional horse-power motor and therefore constitute no particular hazard is a fallacy.

Heavy flywheels and the high inertia of the moving parts can remove a finger with the precision of a rotary saw, and the abominable practice of oiling projectors while they are in motion has added to this hazard. Neckties can catch in moving parts, and care should be taken that handkerchiefs do not hang from the hip pocket and catch in gears or chains.

Some projectors have a very small clearance between sprockets and idler rollers when open. A finger carelessly placed on the moving film may be carried under the roller and badly mangled by the sprocket teeth. Sheet metal cones should be attached to the front of every lamphouse so that there will be absolutely no light leakage from cooling plate to lamphouse. It is a recognized fact that many of the old-time projectionists lost out due to eyestrain from this source.

Manufacturers have gone to considerable trouble to place grills and screens over the commutators and moving parts of motor generators, projector motors, exhaust fans and arc feed motors; but it is safe to say that less than ten per cent of these guards are retained after the equipment is installed, usually being removed and lost. The practice of permitting ordinary electric fans to be placed in a projection room is exceedingly dangerous. The State of Ohio recommends that any such fan, regardless of positioning, should be covered

on all sides with hardware cloth of a mesh small enough so that a handful of 5/8-inch ball bearings dropped on the guard will not fall through.

Careless or clumsy use of hand tools results in many serious injuries due largely to the fact that cuts and bruises become infected through lack of attention. One of the commonest accidents in projection rooms is caused by a screwdriver slipping and stabbing the projectionist. Almost as frequent are injuries caused by sharp slivers of steel being thrown from cold chisels or improperly used hammers. Snapping hack saw blades can be extremely dangerous, as the parts may be thrown for a considerable distance. The only cure for this condition is a thorough knowledge of the proper use of hand tools.

● 'It's only 110 Volts . . . '

Electrical: The assumption that it is "only 110 volts" and therefore not dangerous is a first-class joke, cases being on record of deaths being caused by coming into contact with 70 volts a.c. It is often assumed that the power packs used in conjunction with amplifiers are not dangerous because, while they may deliver 200 or 300 volts, the amperage is low. The fallacy of this is proved by the electrocution of a Lima, Ohio, police radio operator who came in contact with the plate circuit of a small pre-amplifier. He was killed instantly, the power supply being less than 250 volts.

Safety switches placed on amplifiers should not be strapped out, and, if defective, they should be replaced. Particular attention should be given to discharging high-voltage condenser banks before attempting to service an amplifier. A good condenser will retain a charge overnight or longer.

The personal health of the projectionist, as a result of his own negligence, usually receives less attention than even the most neglected piece of projection equipment. There can be no excuse for the Union officials permitting a member to work in a projection room which is improperly ventilated (an 89-cent fan set in an open window does not constitute proper ventilation). I have heard many complaints by sound engineers regarding the accumulation of carbon dust and precipitated material from arc lamp houses in sufficient quantity inside the amplifiers to cause noise and, in some cases, completely cut off the sound. Some projection rooms have an accumulation of lamphouse deposit hanging from the ceiling above the lamp rivalling the stalactite formations of the Grand Caverns.

It is useless to go into detail regarding sanitary facilities in projection rooms, because the projectionists and the unions have permitted these matters to be neglected over a long term of years and will probably continue to neglect them in the future. The fact remains, however, that proper action can usually be secured if the Union really wishes to do something about it. Public officials now are more receptive than ever before to such requests.

● Loose Obstructions Dangerous

The careless placing of conduit and flexible conductors where they can be tripped over can easily be avoided when equipment is installed. Floor coverings with snags or breaks are very dangerous and should be replaced or carefully cemented down. Grease or oil spots or carelessness in dropping carbon stubs can cause a bad spill which may result in broken bones. Bare concrete floors have been pointed out as a menace to the life of projector parts and film; however, the same dust is just as effective in injuring projectionist's lungs.

Some years ago it was customary to paint projection room floors with sodium silicate (water glass). This was fairly successful in giving a smooth finish to the floor and in preventing, for a considerable time, the dusting off of the cement surface. In damp weather, however, this material becomes a semi-conductor of electricity and there are possibilities of a violent shock if all equipment is not carefully grounded.

Examining film by rewinding it with the edges held between the thumb and forefinger is particularly dangerous. The exchanges maintain, and correctly, that this tends to crack sprocket holes and damage the film; but the real danger is the sharp edges of the film which will cut into the flesh like a razor blade, the dirt or dust on the film offering an excellent means of infection. A bottle of iodine and a number of bandages should be handy in every projection room. [Ed.'s Note: *Mercurochrome, widely used as a "substitute" for iodine, is nothing of the sort, not having as much strength.*]

Chemicals in common use in the projection room deserve some attention. Consistent exposure of any part of the body to lubricating grease and oils often results in serious irritation and may induce skin cancer. Many projectionists, in order to save their good clothes, keep at hand a pair of dirty oily trousers which they put on when making extensive repairs to their equipment. These oil-soaked clothes frequently result in painful sores due to the fact that certain skins are allergic to petroleum products. It is an established fact that ninety per cent of the skin cancer epidemics which periodically break out in various industries are the direct result of the continued contact with dirty clothes saturated with oil or commercial solvents.

Many projectionists compound their own film cement, some of which is at once both wonderful and frightful. Frequently, glacial acetic acid is used. The fumes of this poison are violently irritating to the nasal passages and throat, and the projectionist who gets it on his fingers may carelessly rub his eyes, thereby occasioning a dangerous inflammation.

● Carelessness With Chemicals

The most flagrant disregard of common sense and safety is the use of gasoline or naphtha anywhere in a theatre. Few realize that the fumes of these solvents are heavier than air, will flow down ventilating shafts and settle close to the floor, *remaining there for hours* ready to explode at the slightest spark or open flame. This fact suggests an interesting experiment:

A piece of ordinary spouting or bent tin from six to ten feet long is laid from the edge of a table at an angle down to the floor. On the floor at the bottom of the trough place a lighted candle. At the top of the spouting place a warmed teaspoon into which has been dropped five drops of gasoline or naptha. Use an eye dropper, not a gasoline can, as this demonstration is not a suggested

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Vapor Lamps N. G. For Early Picture Projection Use

Considered opinion of an authority on possible application soon of mercury vapor lamps to motion picture projection:

"Mercury vapor lamps, if operated at extremely high pressures (in the neighborhood of 25 atmospheres), have an extremely high intrinsic brightness which compares very favorably with that of the high-intensity arc. The dimensions of the incandescent gas stream, which serves at the light source, are not favorable for application to motion picture projection in that the gas stream consists of a thread of light about 1 to 2 mm. wide and about 25 mm. long.

"For 35 mm. projection, the light source should be approximately square and measure approximately ½" on a side. The ill-suited proportions of the mercury vapor light source, therefore, prevent its application to motion picture projection, even though the inconvenience of water cooling the lamp did not constitute another serious objection.

"Until such time as the source dimensions of this lamp can be materially altered, its application will have to be confined to fields other than picture projection."

J. H. Kurlander
Westinghouse Lamp Works

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means for suicide. In a few seconds the gasoline will have evaporated and suddenly a trail of flame will start at the candle and go up the entire length of the metal trough, showing that the gasoline fumes, being heavier than air, will travel downhill. Fire underwriters have records of entire homes being moved as far as 100 feet due to the use of gasoline as a cleaner for hardwood floors, the fumes traveling down through a hot air register and igniting at the furnace.

Many projectionists use carbon tetrachloride, carbona, or other non-imflammable solvents to wash projector parts. While this material is fireproof, attention is directed to the fact that the commercial product has many impurities and continued inhalation of the fumes from these materials can cause serious injury to the heart and lungs. Like any other solvent, they should be used *only* in a well ventilated room.

Another unwise practice is the storing of film cement in glass bottles, excepting possibly the small one- or two-ounce bottles used with an applicator. There are several instances of these bottles being tightly corked and exploding, due to the expansion of the solvent fumes of the cement. A tin can with a screw top is by far the safest item. If they should explode, they at least won't throw glass splinters around.

● Port Shutter Hazards

Another source of injury is rather rare, but when it occurs the results are always unpleasant, namely, the dropping of port shutters on the projectionist's fingers. Many fire officials and theatre inspectors impose silly rulings that, regardless how efficient is the fuse system used on these shutters, they must be supported by a sashcord or other combustible cord. This is a nit-wit idea. The abnormal heat in the projection room quickly rots out cotton or hemp fibres, which have a habit of parting and dropping a port cover just as the projectionist has his hand placed on the port. Broken or badly lacerated fingers are usually the result.

The practice of installing port shutters weighing as much as fifty pounds and not counter balancing them is also to be condemned. Many such shutters are so heavy that if they were ever released by the fuse system, they would not only crash shut but their weight would tear the entire framework off the wall, and possibly the shutter might have to be retrieved from the first floor.

It is the writer's opinion that there is a separate section of Hell screened off for the persons originally responsible for the construction of a projection room door approximately 18 inches wide and 5 feet high. Such doors are an abomination.

The projectionist will find it necessary occasionally to go back stage to check horns or other associated equipment. Extreme care should be used in working in what may be unfamiliar territory. Modern speaker assemblies weigh from 500 to 4000 pounds, and are easily overbalanced or tipped. The policy recently inaugurated by a number of local unions of requiring that each member work one week in each theatre of the city in order to familiarize himself with the projection room and its equipment is to be highly recommended, for accidents are more likely to happen to the man working with unfamiliar equipment and in strange surroundings.

A suitable container for carbon stubs is an absolute necessity, but, wherever possible, the place for it, despite the rulings of certain fire inspectors, is within the lamphouse itself; it should be emptied at least once each day, either before or after the day's run. Carrying the hot carbon stub outside the lamp to a container constitutes an unnecessary hazard.

● Constructional Defects

Almost every projection room has a certain number of constructional hazards which include, probably, poorly lighted stairways, or refuse or material piled near the top of the steps, thereby providing a means for instant transportation to the bottom, usually resulting in broken bones. The writer tried this means of exit and cannot recommend it.

Large windows in the projection room, unprotected by bars or a fire escape, are a definite hazard, as it is entirely possible for a projectionist to be blinded by smoke or flame and fall through one of these open windows

Accidents do not "just happen." They are caused by doing something the wrong way, and only continued vigilance, thought, and study will reduce the rather high accident rate of the theatrical profession.

Many projectionists rely on accident insurance policies instead of on accident prevention programs, boasting that they have so much insurance that they are worth more dead than alive. Only that projectionist who has a sufficient accident and life insurance the income from which will equal his present and future salary possibilities has the right to make this statement; and few of us have that right.

● Annual Income Is What?

As a concluding thought, and for the benefit of both projectionists and theatre owners, experience qualifies me to make this remark: no projectionist can handle his equipment in a safe and satisfactory manner if his mind is occupied with the problem of how he is going to pay last week's bills with next week's salary; and the same holds true for the employee who may be wondering whether he is going to be compelled to go on strike in order to get his salary next Saturday night. Preoccupation with matters outside the theatre means a projectionist and an audience in danger within the theatre.

I. P. Examines New 'Dream' Screen From the West

WEST COAST commentators have been indulging in superlatives to describe the new Flat Light screen manufactured in Los Angeles, causing I. P. to investigate this product for which such extraordinary claims were made, such as, for example, "30% more light than any other screen on the market."

I. P. found that this screen contains a blue pigment which, to the unaided layman's eyes, naturally emphasizes the blue and gives the impression of more light. More important, neither the type nor number of perforations are wholly acceptable on the basis of present-day standards of visual and sound projection. The type of hole seems to definitely impair definition; while there are so few perforations by comparison with other types of screens as to render perfectly understandable the high reflectivity obtained.

One sound engineer found that this particular screen would require five times as many perforations as it now has in order to render acceptable sound transmission. Similar tests by an independent laboratory disclosed that the screen in its present form had a slightly higher reflectivity than any other type; but it is questionable, to say the least, whether this figure could be maintained were sufficient perforations included.

Noteworthy is the fact that this new screen is reported to cost more than $2 per square foot, as contrasted with the price of 40 cents for other screen types.

The foregoing is offered just to keep the record straight.—J. J. F.

DRAKE, ERPI PRESIDENT, DEAD

WHITFORD DRAKE, 55, President of Electrical Research Products, Inc., and one of the major personalities behind the commercial development of sound motion pictures, died on Aug. 24 at his summer home in Chatham, Mass.

Mr. Drake was born in Waltham, Mass. He attended Harvard from 1899 to 1902, going from there to the U. S. Naval Academy, where he stood second in his class, graduating in 1906. He entered M. I. T. in 1908 and received an M.S. Degree there in 1911.

Mr. Drake served in the Navy from 1902 to 1919, resigning the rank of Commander to accept a position as Works Manager of the Baltimore Shipbuilding and Drydock Co. Acting in this capacity until 1922, he joined the Winchester Repeating Arms Co. as factory manager and president of six subsidiary companies.

With W. E. 14 Years

In 1924 he joined W. E. as assistant operating superintendent of the Kearny Works. Later he was made operating manager of the Commercial Dept. He joined Erpi upon the formation of that company in 1927, and about a year later was made a vice-president. In 1936 he was named executive vice-president, and in 1937 was elected president.

Projection Optics: Focal Length and Other Data Anent Optics

BY ENGINEERING DEPARTMENT, ZEISS IKON, A. G.

ONE frequently encounters in practice widely varying aspects of the meaning of such terms as focal length, foci, *etc.* For instance, the crater of an arc-lamp is described as being situated at the focus of the mirror. Yet, again, reference is made to a variation of the focal distance or focal intercept when varying the distance of the crater from the mirror. On the other hand, the point where the rays experience their greatest concentration, *i.e.* the point where the film gate is situated, is frequently referred to as the *focus.* In these circumstances it would not seem out of place to clearly define the meaning of the respective terms.

In the first place, let us consider a thin lens (Fig. 1). A source of light situated at the point 1 and represented in the figure by an arrow, forms on the other side of the lens an image at the point 1′. These points 1 and 1′ are points of intersection of the rays and the optic axis, and the distances of these points from the centre of the lens are called *focal intercepts.* In the diagram they are denoted by a and b.

When the source of light is moved closer up to the lens, say, to position 2, an image will be formed at 2′ on the other side of the lens, which is farther away from the lens than the image 1′. The focal intercept, accordingly, becomes smaller on the left side of the lens, while it becomes greater on the right side.

● The 'Principal Focus'

On the source of light being moved still nearer to the lens the image points on the other side will wander farther and farther away, until ultimately the rays leave the lens in the form of a parallel beam. The point where the source of light is now situated is called the

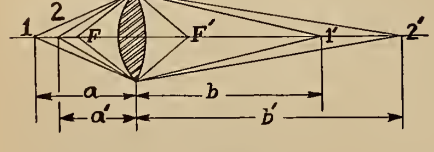


FIGURE 1

principal focus of the lens. In the diagram it is denoted by F. Conversely, a beam of parallel rays incident upon the lens in the direction of the optic axis may be said to meet at the principal focus. Accordingly the pencil of rays may be made to enter the lens from the left in a direction parallel to the axis, in which case it will form an image at the second principal focus f′ of the lens.

In the case of a symmetrical lens, the second principal focus will be at the same distance from the middle of the lens as the first principal focus on the left side of the lens. The distance of the principal focus from the lens is called the *focal length* of the lens.

It may be useful to note that conjugate intercepts are related to the focal length by the following equations:

$$\frac{1}{a} + \frac{1}{b} = \frac{1}{f}, \text{ or } f = \frac{a \cdot b}{a + b}$$

The ratio b:a expresses the ratio of magnification which obtains between the image and the object. In the diagram b:a equals 2:1, and b′:a′ equals 4:1, that is to say, in the first case the magnification is 2 times, and in the second it is 4 times.

We may now proceed to the simplest optical application of the mirror principle, that is to say, the direct concentration of rays by means of a concave mirror. The same laws apply here as in the case of the lens. The difference between a mirror and a lens is, that in consequence of reflection of the rays at the surface of the mirror, the source of light is situated on the same side as the image, hence the mirror has one principal focus only. In this case, likewise, the rays which proceed from the principal focus leave the mirror in the form of a parallel beam.

(With all concave mirrors with the exception of the parabolic type this law holds good strictly only for small angles of aperture. At larger angles of aperture the reflected rays depart from the parallel course. For the practical purposes with which we are here concerned, these deviations are not of any significance, so we may well ignore them).

● Filling the Aperture

Where the rays of light are to be concentrated by means of a mirror, the source of light requires to be moved out of focus farther away from the mirror. Fig. 2 illustrates a practical case. The actual source of light is represented by the crater of an arc-lamp under a load of 25 amps. It has a diameter of 7 mm. In order to fill the aperture completely with light it is necessary to project upon the film a patch of light of about 40 mm diameter. The image of the crater requires, accordingly, to be six times larger than the object. The correct relations will result by making the focal intercept a=110 mm. and the intercept b=660 mm., the focal length of the mirror being 95 mm. It will be seen, accordingly, that in this case the distance of the crater from the mirror, that is, the focal intercept, exceeds the focal length by 15 mm.

The available yield of light derived from a mirror-lamp depends upon the angle at which the rays are received by the mirror. Clearly, this should be measured with respect to where the crater is situated when projecting. With many concave mirrors which are employed for direct projection in this way —such as spherical and aspherical mirrors embodying modifications of the aspherical form—the focal length is inscribed on the mirror instead of the practically significant distance of the crater from the mirror. This may prove misleading and tempt a projectionist to measure the angle of the aperture of the mirror from the principal focus. If that were done, it will be seen from Fig. 2 that a larger angle of aperture would be obtained than can be turned to account when projecting, the angle being 135 degrees instead of 125 degrees. This angle of aperture of 135 degrees would then have to its credit an amount of exploited light which is 10 per cent in excess of the actually available light.

It is different in the case of a parabolic mirror. In this mirror the rays

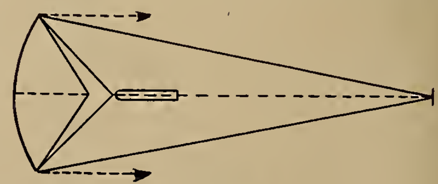


FIGURE 2

are designed to leave it in the form of a parallel beam, and are concentrated upon the film gate by the intervention of a condenser-lens. In this case, there-

fore, the crater should be located at the principal focus of the mirror, while the angle of aperture would be measured with respect to the principal focus.

● Elliptical Mirror Requisites

Conditions are rather more compli-

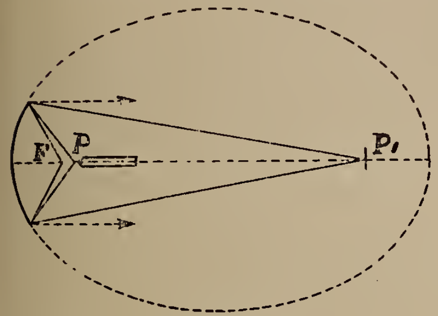


FIGURE 3

cated in the case of the elliptical mirror and the modified form of mirror derived therefrom. These mirrors are segments of an ellipse as shown in cross-section in Fig. 3.

In the ellipse there are two points, P and P′, which are so related that all rays proceeding from P are reflected towards P′. In geometry these points are likewise known as *foci.* When projecting with cinematograph apparatus furnished with a mirror of this kind, the crater of the arc-lamp is placed at one of these geometrical foci, while the film-gate occupies a position at the other geometrical focus of the ellipse.

Optically considered, these points are not the foci of the mirror, since the fundamental property of the optical focus is that the rays proceeding from it emerge from the mirror in the form of a beam parallel to the axis. In Fig. 3 it is denoted by the letter F. In order, however, to obviate any erroneous conclusions regarding the exploitable amount of light, some makers specify the actual distance of the crater from the mirror, which should be observed when projecting, instead of stating the focal length of the mirror.

Borgeson Heads the Field To Win Grand Award in Q. & A. Contest

HEREWITH is presented a likeness of Lawrence Borgeson, winner of the Grand Award in the Question & Answer Contest which ran in I. P. during the first six months of this year. Borgeson, who hails from Pasadena, Calif., and is a member of I. A. Local Union 150, closed strongly to establish a clean-cut lead over Everett Renfroe, of Chicago, who in the early days of the Contest bid fair to spreadeagle the field.

Nothing of the spectacular marked Borgeson's performance in winning the Grand Award; rather were his efforts a fine tribute to his dogged determination and persistence in staying in the game even when it appeared that he was hopelessly outclassed. He was unplaced in February and March; then in April he was among those who gained the Consolation bracket; until finally he broke through a winner in May, repeated his triumph in June and placed second in July to H. D. Taylor, who barely squeaked home in front. Borgeson's efforts in May and June, particularly the former, returned him home the winner.

Renfroe started out like a world-beater by placing first twice in succession and there never was any doubt that he was the man to beat. On purely theoretical questions Renfroe reigned supreme, with nobody even close to him. When the emphasis shifted to questions anent practical projection matters, however, Renfroe did not do so well, thus allowing those trailing him to close the gap and, ultimately, forge ahead.

The nature of the Grand Award to Borgeson, already surfeited with run-of-the-mill prizes won during the Contest, will have to wait upon his expressed preference in response to a list of articles sent to him.

● Many Fine Averages

Neither Borgeson nor Renfroe made a show of the field, the Contest reflecting no little credit upon H. D. Taylor, of Raleigh, N. C.; K. P. Kenworthy, Moscow, Idaho; T. P. Hover, Lima, Ohio; Don Howard, Rawlins, Wyo.;

LAWRENCE BORGESON
Winner of Grand Award in I. P. Question & Answer Contest

George Wilde, Columbia, Ill.; Chester Ellison, Reading, Mass.; Leo Cimikowski, Norwich, Conn.; Jack Leatherman, Jacksonville, Fla.; W. Fenwick, Victoria, B. C., Can.; Ray Mowery, Mahanoy City, Pa.; Roy Arnston, Minneapolis, Minn.; Carl Rossi, Brooklyn, N. Y.; Roy Beal, Ft. Wayne, Ind.; T. Morisawa, Los Angeles, Calif., and numerous others who submitted consistently good papers.

The Contest attracted an average of 273 entries each month over the six-months period, but this figure does not even begin to approach the number who worked out the answers but, for one reason or another, failed to send them in. Statements to this effect have reached I. P. from such men no less than from actual contestants. Overall the Contest appears to have done much good in sharpening the wits of a representative number of craftsmen in every section of the country.

Excerpts from a few typical comments anent the Contest are appended hereto:

Many thanks for the valuable headset I received as first prize in the Q. & A. Contest. I planned to buy a new headset, but not one of high cost and extremely high quality of that which you sent on. You could not have pleased me more with your choice of an award.

I have enjoyed and greatly benefitted through the Contest, and I should like to see future events along similar lines in I. P. in the future.

H. D. TAYLOR, Raleigh, N. C.

Thanks for the very fine headphones. They will come in handy for testing purposes where a high-impedance phone is required. One of the finest features of the headset is its extreme lightness.

It has been a thrill and a pleasure to participate in the Contest, and I believe the experience and knowledge gained in thinking out the various problems has been extremely profitable. The time put in has been well spent.

The article on the Simplex sound system provided information and an incentive to learn something about that new system, and I feel that many of us have profited greatly by pondering over the questions attached to that article—even if we missed some of the questions. (I'm still kicking myself for not stating in Question 22 that it is also advisable to check the plate circuit of the lower 6L6 for an open circuit, such as a burned-out output transformer primary. While meter fluctuation is not noted in this circumstance in all power amplifiers, it would be if the ratio of the normal peak grid swing to the steady normal bias was relatively large, approaching unity).

You have stated from time to time that projectionists are an unresponsive group as a whole, and that you feel they don't keep up with the developments of the craft as well as they might. You are no doubt right in part, but there are many men who are always trying to learn more. For example, the Q. & A. articles have been far more widely read (and studied, too) than the answer response indicates. I know many projectionists who have read these articles and given considerable thought to the questions, even though they have never turned in answers. Too many men are afraid someone will find out that they make mistakes; but don't we all?

L. G. BORGESON, Pasadena, Calif.

Some Film-Handling Problems of Exchange Operations

A REPORT OF THE S. M. P. E. EXCHANGE PRACTICE COMMITTEE†

Among the subjects discussed in this brief account of the activities of this Committee during the past six months are the following: reel bands, splicing, processing and waxing, condition of reels in theatres and exchanges, cleaning films, instructional material to accompany films, and film cases.

MEETINGS of the Committee have been held regularly each month, and although at this time the Committee does not have a considerable number of concrete facts to report, nevertheless these meetings have proved of considerable value in enabling the exchange heads of various companies to discuss their problems with one another, to arrive at workable and satisfactory solutions of these problems, and to pave the way for solving other existing difficulties in exchange operations . . .

Among the subjects discussed at the various meetings were the following:

Reel Bands.—A collection of reel bands used by the various companies was made, which showed that no important differences existed among them, although it was the opinion of the Committee that uniformity in the nature of the instructions placed upon the reel bands would be desirable.

Splicing.— Considerable study was given to the problem of getting the operators in the exchanges to splice film properly, even when they are supplied with proper slicing equipment.

A study of splicing machines and methods is in progress, and will be reported upon later. The question of whether it is advisable or not to use bicarbonate of soda or other solvent to make the splices, or merely a simple scraping operation to remove grease and dirt completely and thus allow a homogeneous weld to be made, was given considerable attention. The question also arose as to the proper direction in which to make splices, and it was agreed that the trailing film (with respect to rotation of the sprocket) should be spliced on top of the leading film. Less trouble seems to occur when the patches are made in this manner rather than in the opposite manner, and accordingly this procedure has been adopted in all the exchanges represented on the Committee.

● Divided On Waxing

Processing and Waxing.—Although for a long time consideration has been given to the subject of processing and waxing film, the Committee is not prepared at the present time to report upon the subject. Some companies use one system and some another, and apparently each system has its advantages and disadvantages, depending upon the point of view and the application. The Committee hopes to report further on the subject at a later date.

Condition of Reels in Theatres and Exchanges.—Objections have come to the Exchange Practice Committee from the Projection Practice Committee and others to the effect that the condition of reels received in theatres from exchanges is often very bad. In some instances the flanges are bent badly, and in other instances the reel has been so roughly handled as to rip the center hub out of place, thus making it impossible to run the reel in the projection machine.

Samples of mutilated reels were exhibited at one of the meetings and considerable attention was given to questions that had been raised regarding the thickness of the metal and the ribbing and beading, which determines the stiffness; to burs, which arise in stamping, and which are likely to cut the projectionists' hands; the size of the finger holes which, it is asserted, are sometimes too small to permit removing the reels easily from the projector magazines; and other less serious questions which are receiving the attention of the Committee.

The manner in which film reels and cases are handled in exchanges and by carriers is extremely important, and the Committee is endeavoring to change the point of view of the industry that the rough handling that is now regarded as ordinary "wear and tear" should not be regarded as ordinary.

● Should Film Be Cleaned?

Cleaning Films.—The questions before the Committee with regard to film cleaning are as follows:

(1) Does current film require cleaning? (2) If so, by whom and where? (3) By what type of machine?

With regard to *1*, the question was mainly an economic one, as to whether the expense and labor would be justified by improvements in condition of the film and its length of life. The commercial life of film varies: it is generally shorter than it used to be, and seldom is longer than a year, which makes the need of lengthening its life further somewhat doubtful.

On the other hand, the Projection Practice Committee has indicated that even in the case of new film, in use by highly trained personnel, oil and dirt will get upon the film and within a week will be seen in the image upon the screen. In the interest of better screen-images, it would appear that cleaning is necessary, aside from the question of life of the film.

Instructional Material.—Investigations are being made to determine what degree of uniformity exists with regard to labels, *etc.*, sent to theatres with the reels from the exchanges. As this work has not been completed, it will be reported upon at a future date.

Film Cases.—Many criticisms have come to the Committee concerning the manner in which film cases are handled in exchanges and theatres and by carriers; and an attempt is being made to induce the carriers in particular to exercise greater care in handling the containers.

Various suggestions have been made also for facilitating the handling of heavy film cases in exchange vaults, the suggestion being that the upper racks be reserved for single-reel pictures so that the heavier loads will not have to be lifted very high. The distribution of the cases in the vaults could be so graded as always to place the heavier loads at the bottom.

†Journal of the Soc. Mot. Pict. Eng., XXX (June, 1938), No. 6.

2-Men Shift Appeal Wins in N. Y. State

Newburgh, N. Y., ordinance requiring 2-men projection shifts and licensing by a local board has been upheld by the N. Y. State Appellate Division after lengthy litigation. Theatre interests contended that ordinance was unconstitutional, was enacted in bath faith (the L. U. president is also Mayor) and that the city exceeded its charter powers. Plaintiff was assessed costs of action.

Portion of law requiring local residence as test of eligibility for projectionist license was disapproved by the Court, but this section had already been repealed. Ordinance provides for licensing board of five members: two projectionists, one master electrician, the city inspector and the fire chief, all for terms of three years without pay.

Appellate decision being unanimous, plaintiffs must obtain consent before intended appeal to highest State court. Argument will be on Sept. 26. James J. Finn, editor of I. P., appeared for L. U. 45 on technical phases of the trial.

Old- and New-Style Motiograph Take-Ups

In Which Two Projectionists Indulge in Some Long-Distance Comparisons—Only to Establish That They Are Discussing Two Entirely Different Equipments

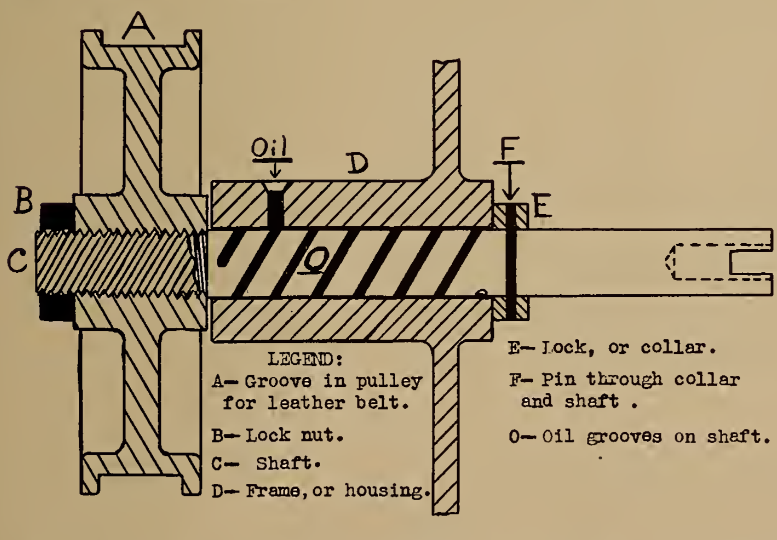
I HAVE found Mr. A. C. Schroeder's articles in general extremely interesting and helpful; but after reading his recent articles[1] on the Motiograph take-up I was forced to conclude that he knows very little about this particular equipment.

I am enclosing a drawing of the take-up on my Motiograph, which takes-up smoothly and evenly, regardless of the hub size. What kind of equipment does Mr. Schroeder have that causes such take-up troubles? What manufacturer would make a belt that wouldn't work? My belts have run as long as four years without any trouble.

The groove in pulley A, in the accompanying sketch, is where the belt runs; there is also a similar one in the projector head about one-half the size of A. The slipping occurs on these two pulleys, which takes the place of the clutch take-up. As for Mr. Schroeder's use of flat and rat-tail files on the shaft, I would say "No." Use of the proper kind and amount of oil would nip the trouble in the bud.

I have been running Motiograph projectors since 1925, and I know that they are not as illustrated by Mr. Schroeder. I should like to see my drawing published.

VANNIE L. HARRIS, JR.
Seminole Theatre, Homestead, Fla.



To which Mr. Schroeder makes the following reply:

Regarding the comments by Mr. Harris, it is possible that I was not explicit enough in my article. However, it appears that he is discussing a different take-up. The drawing that accompanied my article was made from a sketch obtained in the showrooms of B. F. Shearer, Motiograph distributor in Los Angeles. It is the latest type Motiograph take-up and differs from that used by Mr. Harris.

The take-up was taken from a machine on the floor, completely disassembled, and a rough sketch made of every part, including one similar to Fig. 5 of my article (I. P. for July, p. 19). The dimensions may be slightly off, but otherwise it is correct. Perhaps Mr. Harris got the impression that our belt trouble was occasioned by the Motiograph. This is not so: the trouble was caused by the manufacturer of the sound equipment.

I stated that a file was to be used to remove a shoulder or to remove high spots that caused binding. These conditions do occur, not only in good and in bad motion picture projectors but also in any other type of mechanism. Oil will not enable a part to climb over a shoulder, nor will it remove metal at points where something "pinches" a bit tightly. While my article mentioned numerous *possible* points of trouble, I did not mean to imply that these troubles are *always* present.

One last point: reading between the lines, I gather that Mr. Harris thinks I am subtly "slamming" the Motiograph. This is emphatically not so, because I regard the Motiograph very highly and consider it as good a picture machine as is made today.

Supplementing Mr. Schroeder's comment is the following observation by Les Abbott, Motiograph sales manager:

Apparently Messrs. Harris and Schroeder have in mind two entirely different take-ups. About the time the Model K Motiograph was introduced the 2000-foot reel was adopted as standard. Certain municipal authorities disapproved our old-style, flat-belt take-up, which depended entirely upon slippage of the belt to compensate for friction and the speed of the take-up reel. Due to the belt becoming saturated with oil, the authorities concluded that it was unsatisfactory; consequently our new cone friction take-up was designed.

Mr. Schroeder's article did not cover our old take-up but only our new cone friction take-up that is being marketed today.

[1] "Take-Up Troubles: How to Locate and Correct Them," by A. C. Schroeder, in I. P. for June and July, 1938.

WATER-COOLED 'MIDGET SUN' ANNOUNCED BY G.E.

A MIDGET SUN in the form of a 1000-watt mercury lamp, no larger than a cigarette yet designed to attain a brilliancy equivalent to about one fifth that of the sun's surface, is announced by General Electric at Nela Park, Cleveland. Since the light source, an arc, is highly concentrated and is approximately twelve times as brilliant as the incandescent filament of a 1000-watt standard projection lamp, Nela engineers believe it will revolutionize lighting practice in numerous fields of light projection. Numerous laboratory tests indicate that the new lamp can be used to great advantage in photo-engraving work, in blueprinting, photo-enlarging, in searchlights, and for therapeutic application.

The lamp consists of a little quartz tube. Confined within a tiny bore inside the tube is a globule of mercury and a trace of argon gas. Each end of the quartz tube is furnished with a brass ferrule which provides proper electrical contact.

● Water-Cooling System

In producing so brilliant a light, the midget sun develops such high pressure and heat as to destroy itself unless the lamp is properly water-cooled. By developing an ingenious water cooling-jacket, permitting three quarts of water per minute to flow past the gleaming mercury lamp, G. E. engineers found a practical way to carry off the excess heat without affecting the light output. The cylindrical glass portion of the water jacket is about the size of a shotgun cartridge. A screw adjustment at one end of the jacket permits easy insertion and removal of the quartz lamp. Metal connections for water intake and outlet are located at either end of this water-cooling accessory.

It is necessary to equip the cooling system with a pressure-operated switch and magnetic valve because (1) the water in the jacket must be moving before the lamp is lighted, and (2) the lamp must be turned off automatically in the event of failure or reduction of the water supply.

The brilliant light produced by the quartz capillary lamp emanates from a narrow arc stream not much wider or longer than a common pin. Compared to the bluish light emitted by conventional mercury lamps, radiation from the new 1000-watt source is much whiter.

When the water jacket is made of quartz instead of hard glass. the unit emits a wealth of ultraviolet radiation. Special glass that screens out dangerous ultraviolet rays not found in natural sunlight at earth levels may be used instead of quartz, Nela laboratory engineers said. Although the water in the jacket absorbs approximately 90 per cent of the heat generated, it allows practically all the ultraviolet and visible radiation to reach the outer envelope.

F. H. RICHARDSON VOTES FOR REVERSED PRINTS

THAT distinguished toiler in the projection vineyards, Mr. F. H. Richardson, honored us with a visit recently, primarily, we suspect, to enlist our support for a new idea which he is advocating strenuously—namely, that the exchanges ship prints to theatres mounted in reverse, with the trailer outside. The idea sounds and reads well, particularly if complete acceptance is extended to the idea that almost all theatres inspect prints before running, that almost all projectionists report for duty at least one-half hour before showtime, and that all theatres switch prints to house reels before projecting.

We agree that it's not a bad idea, and we were almost ready to go for it whole hog until we got to thinking about these smaller theatres with three, or even daily, changes of program; about the thousands of theatres where projectionists barely make the show deadline; about ditto number of theatres that use exchange reels (it's possible, if disastrous), and about hundreds of daily film deliveries that reach the theatres, in all seasons and in temperatures encompassing a range of 100 degrees, a few minutes before showtime.

There aren't many Broadways with numerous first-run, week-stand showings along the American film front; in fact, statistics show that 75% of movie theatres average about 700 seats—meaning small towns and short runs. Nor can we ignore the possible effect upon exchange inspection of the knowledge that delivery of a reverse print would put Mr. Projectionist squarely on the w. k. spot. Ye gods! isn't there enough taking-over of exchange chores by projectionists now?

Before saying either yes or no to Rich's latest idea we should like a few expressions from the field. Then we shall see.

RADIART CHANGES QUARTERS

Increasing demand for products of Radiart Lamp Corp. has necessitated larger quarters at 268 Sherman Ave., Newark, N. J. Company makes all types of incandescent lamps, including p. e. cell exciters, reproducers, *etc.*

FAMOUS-CANADIAN SETS UP NEW SUPPLY SUBSIDIARY

The creation of General Theatre Supply Co., Ltd., as a subsidiary of Famous Players Canadian Corp. has been announced. The new subsidiary has a main office in Toronto, a branch in Montreal, and offices will be established immediately in Winnipeg and Vancouver to serve the west.

The new company replaces Canadian Theatre & Electrical Supplies, Ltd., of which Charles A. Dentelbeck was general manager. He has been named to the executive staff at the home office of Famous Players as director of projection for all theatres in the circuit. Ed Harris is chief sound engineer. General manager of the new company is Ben Burko, veteran equipment man of Montreal, whose business there has been absorbed in the new enterprise. The Theatre Operating Service, Ltd., Toronto, of which E. V. Armstrong was general manager, ceases as an active unit.

The General Office of the I. A. T. S. E., removed from New York to Washington in 1934, will be moved back to New York about Sept. 15. New address will be International Building (Radio City) 630 Fifth Avenue, N. Y. City. Move described as "better and more convenient for all concerned to locate centrally in N. Y. City."

NEW KAPLAN PEDESTAL

Reduced vibration in a new type of projector pedestal is claimed by the Sam Kaplan Mfg. & Supply Co. The heavy weight of the pedestal plus the placing of the pivot almost under the projector are factors which have done much to minimize vibration, it is asserted. Rigid alignment for the heaviest of modern lamps is pro-

vided by the design of the lamphouse carriage arm.

Another feature is the tilting device which is concealed except for the handwheel. Angles of 3° up to 15° down are available. These can be increased by taper angles, which are supplied as needed. Rapid sweep through 3½° is provided through the lateral adjusting device.

Concealed shielded wiring is made possible through a large base compartment with a wide door for access and a removable plate for conduit connections. A 100-ampere knife switch for arc control is at the back of the pedestal and wired through the base compartment. Two 30-ampere motor switches are at the sides. Connections for the motor and the changeover device are afforded by two-pole and three-pole twist lock receptacles.

FRANCE CONSIDERS ACETATE STOCK FOR ALL FILM RELEASES

The French Ministry of the Interior has recently devoted considerable study to the problem of reducing the fire hazard in moving picture theatres, according to a report by the American Commercial Attache, Paris. The study revealed that the majority of accidents resulting from the films taking fire occur generally at the time that a new reel is wound on or when a reel is finishing. In order to eliminate this hazard, the French authorities are considering the enactment of new regulations to insure the uninflammability of the blank ends at the beginning and the end of the reels.

Although no official text has yet been made public, it is reported that effective May 1 new regulations will require that the blank pieces at the ends of the movie reels be in uninflammable acetate film for a length of 8 meters at both ends of the reels. The problems in connection with the use of uninflammable materials for all films is being studied by the French authorities.

S.O.S. CORP. NAME CHANGE

S.O.S. Cinema Supply Corp. is the new corporate name for the now well-known S.O.S. Corp. of 636 Eleventh Ave., N. Y. City. There has been no change in policy, ownership or executive personnel. New title is intended to eliminate possible confusion as to whether company handles all cinema supplies, which it does. New catalog is due soon.

NEW WHOLESALE CATALOG

Wholesale Radio Service Co. announces the release of its new Fall-Winter Catalog, No. 73 for the year 1939. Address requests to 100 Sixth Ave., N. Y. City.

A "rigid investigation" of all film laboratories in the N. Y. metropolitan area has been asked by I. A. Laboratory Technicians' Union, Local 702. Request followed the recent explosions at the Warner Bros. Cellulose Products reclaiming plant in Brooklyn. A watch-

man was killed and the building was partly wrecked.

Attention was directed to this and a similar explosion last year at a 20th Century-Fox film storage plant at Little Ferry, N. J., which caused one death and injuries to others. The union says these occurrences "raise questions of fire hazard" in the laboratories and it wants the Fire Department to order precautionary measures where necessary in order to protect laboratory employes and prevent loss of work through fire or explosion.

William Moses, projectionist, was arrested along with manager of Rialto Theatre, New Britain, Conn., for addition of an alleged "obscene" strip to the film "Elysia." Police reviewed picture before okaying engagement, but alleged the unauthentic strip was included later in the week.

Fact that projectionist obviously made addition at direction of the house manager conferred no immunity, said authorities.

Studio Basic Wage Agreement meeting in New York City recently ended in stalemate, with five signatory unions, including I. A., requesting a 10% wage hike, and producers countering with request for 10% reduction. Current scales were left as is until next meeting, scheduled for April, 1939.

Exhibitors and I. A. Projectionists Union in Akron, Ohio, have joined forces in fighting the operation of Keno games in that territory. Scores of clubs and individuals are operating nightly Keno games, and show biz is suffering.

NOTES ON RECENT SOUND FILM DEVELOPMENTS

(*Continued from page* 13)

a violin and a piano. Although the fundamental pitch of both notes is identical, the ear is able to distinguish between them because of the presence in both notes of different overtones. These overtones are considerably higher in pitch than the fundamental tone, and unless our recording and reproducing systems are capable of handling these very high tones, the reproduction will sound flat and colorless. To some extent, this is true of vocal sounds as well.

An excellent test for presence of overtones in reproduced music consists in listening to a full orchestra with one's eyes closed. If the listener can pick out the various instruments readily, at least a major portion of the overtones are being reproduced.

The design and manufacture of such equipment was not easy. Comprehensive tests showed that the amplifier system would have to handle tones of from 40 to 10,000 cycles per second uniformly. The average radios and phonographs to-

day generally do not reproduce below 100 cycles and above 5,000 cycles per second. In the design of such amplifiers, the engineer must be careful to designate component parts of a quality much higher than is considered permissible for ordinary commercial uses. For example, any noise caused by the use of these units in the system will be amplified along with the desired sound and be either recorded or reproduced along with it.

Along with the necessity for being able to record and reproduce faithfully the entire range of fundamentals and overtones, exists the requirement that the system be able to handle large differences in volume. The esthetic and dramatic effects derived from music may be attributed largely to variations in loudness. These variations range from the tinkle of a bell to the sound produced by a full orchestra or a roaring cataract, and must all be reproduced without any suggestion of fuzziness or distortion.

● Hi-Range Prints

Recently some of the major studies have developed a means of adding to the esthetic value of their musical recordings by the use of Hi-range Prints. The musical passages in these prints are recorded at a somewhat higher level than the dialogue portions, so that when the reproducing equipment is set for proper dialogue level, the music will be reproduced at a predetermined level. The Hi-range Print does not necessarily give louder sound, but an extended volume range which has considerable greater dramatic value in the theatre. In effect, greater advantage is being taken of the large power-handling capacity of the modern theatre amplifier and speaker system.

As the range of recorded sound was extended, it was found that a new problem was being encountered. Some actors' and actresses' voices sounded sharp-edged and harsh, especially when pronouncing sibilants like the letter "s." The result was a disagreeable sound to which audiences objected. Also, the high-frequency overtones of certain musical instruments were not well defined and clear.

While these facts were well-known to engineers, it took considerable research work to determine their cause as well as their solution. It was found that it was particularly difficult to obtain sharp photographs of the high frequencies or the upper register of sound on the sound track. Consequently, instead of an exact pattern of the speech or musical sounds, there was merely an approximation. This blurring and distortion was responsible for the aforementioned effect. Originally, attempts were made to overcome the trouble by compensating the recording amplifiers and at the

same time imposing severe limitations on the processing of the film. While these means partially were successful, the film processing was so critical that it became highly desirable to find a simple, efficient means of securing a sharp, clean photograph of these higher overtones.

The answer was found in ultra-violet light recording and printing. The ultra-violet light system, introduced in 1935, utilizes only a very narrow range of light wave-lengths, which eliminates all distortion caused by spreading of the photographed sound image. The resultant print contains high-frequency recording of extremely good definition.

As mentioned previously, the ultimate object of any good reproducing system is the creation of an illusion of reality. This requires the elimination of all extraneous background noise. In this respect, the excellence of pictures today is largely due to the combined efforts of recordists, research engineers and film manufacturers.

Since most of this extraneous noise results from the graininess of the transparent portion of the soundtrack, the obvious answer was to reduce the amount of white track to a minimum. This was accomplished at first by masking in that part of the white track which was not entirely needed for recording purposes. The shutter which did this masking operated automatically, always allowing enough white track to accommodate the recording. There were later developments which improved both the action of this device and the results. Meanwhile film manufacturers had been concentrating on the development of a negative with a more even and finer emulsion.

● Push-Pull Reproduction

More recently, a recording system, known generally as "push-pull," was evolved by RCA engineers. This track permits the reduction of ground noise to a theoretical minimum. Only the area actually occupied by the sound record is transparent, which means that the ratio of ground noise to signal is constant regardless of the loudness of the recorded sound. The track itself consists of two separate tracks, one of which carries the positive half and the other the negative half of the signal. In addition to its inherent freedom from background noise, the push-pull track has another advantage. Better prints can be secured under less rigid limitations during the processing.

At the present time, the push-pull process is being utilized mainly to secure the original recording. This insures a recording with a minimum of background noise which can later be re-recorded as often as is necessary to produce the final print. All modern reproducing equipments should include push-pull or have provisions included to allow the exhibitor to change thereto with a minimum of effort and expense, since prints may be released in the near future.

The final step in the reproduction of

sound in the theatre is the stage loudspeakers. The evolution of the modern two-way cellular speaker arrangement from the speakers originally used is perhaps even more startling than that of the other components. One of the first types of stage speaker equipment involved the use of as many as sixteen dynamic speaker units mounted in towers on each side of the screen and strung along the top. The speaker units required frequent adjustment. Later use was made of a similar arrangement, except that large flat boards or baffles were used to hold the speaker mechanism.

Both of these arrangements had one serious drawback. Since the direction of the sound when it left the speaker was not controlled, much of the sound often reached the ceiling and side walls of the auditorium instead of the audience proper. Where the theatre had moderately good acoustics this was not a serious problem, but in the majority of theatres it was often virtually impossible to follow spoken dialogue because of echo and reverberation.

● Multi-Cellular Speakers

The first step toward the correction of this trouble was the development of the directional baffle which, as its name implies, directed the sound emanating from the speaker toward the audience and away from walls and ceiling. These baffles were placed behind the screen so that the illusion was improved considerably.

At about this time, considerable progress had been made in the recording of the lower frequencies, which are responsible for the richness and depth of orchestral music. With this development, it was found that the single-speaker unit in its directional baffle could not do justice to these lower notes, and often rattled on some particularly loud passages. The apparent answer to this problem was to have a speaker system which had one unit to reproduce the bass notes and a second unit to handle the higher tones. This was exactly what was done. The bass speaker consisted of a large folded baffle in which was mounted a specially designed speaker mechanism, while one or more small directional baffles were used for the high frequencies. A specially designed electrical network divided the "lows" from the "highs," and directed each to their respective speaker units. Such speaker combinations are found in many theatres today and are giving excellent results.

One further change was necessary for greater naturalness. The directional baffles concentrated the higher frequencies in a very narrow region along their axes. A person walking across the auditorium would, therefore, pass through a region with plenty of high frequencies into one of insufficient "highs." If more than one directional baffle were used, the effect would be noticeable at several different points in the auditorium. Furthermore, at those points in the theatre where the high frequencies were not present, the reproduction lacked brilliance and screen presence.

To satisfy this condition, the engineers designed a high-frequency horn which is composed of a number of smaller horns, each of which terminate in a common throat to which a pair of high-efficiency speaker units are attached. Since each of these small horns act as a directional baffle for the high frequencies, the net result is an even spreading of these frequencies throughout the auditorium. The speaker mechanisms used with this horn are carefully designed and manufactured, and will withstand tremendous amounts of acoustic power without damage. This is all the more remarkable because the diaphragm must be light enough to respond faithfully to the very highest frequencies which are being recorded today.

The resulting speaker combination—namely, that of a cellular high-frequency horn and a large low-frequency baffle—provides great power-handling capacity, excellent quality and even distribution of the sound throughout the auditorium.

There is one other point of considerable importance. With even the finest sound equipment and recordings, results may be disappointing if the theatre acoustics are poor. Mention was made previously of attempts by manufacturers to correct such conditions by the redesign of speaker equipment. True, some improvement can be thus effected, but for maximum efficiency the basic fault should be corrected. Too many exhibitors even today are unaware of the fact that acoustic survey and recommendation services are available to them which, in the case of new theatres especially, will definitely obviate later embarrassment and expense.

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Monthly Chat

CONSIDERABLE interest in the question of whether prints should be shipped in reverse by exchanges to theatres has been whipped up among the craft, with a sharp conflict in opinion among those projectionists who work in the larger theatres with comparatively infrequent program changes and those who work the smaller theatres with three or more changes weekly. The latter group is almost unanimous in giving forth an emphatic "No!" to the proposal. Both sides of the story elsewhere herein.

INCANDESCENT lamp companies have been unusually frank in stating that mercury-vapor lamps are not now suitable for motion picture projection work, and will not be unless and until radical improvement is effected therewith. This should set at rest the many irresponsible rumors anent the overnight development of a "revolutionary" light source.

NOTE from Henry Behr, projection chief for Wilmer & Vincent Theatres: "Footage info supplied managers by exchanges is not always accurate, resulting in misinformation in newspaper ads. Exchanges might note the exact footage on the protective film cover and also print thereon the following: 'When footage of this reel is not shown, will the last theatre using the print note same?' If this were done the exchange could furnish accurate running time from the reel band, much more accurate than data from trade publications."

If everything weren't predicated upon exchange cooperation.

OUR prediction of some months ago in this corner anent the gradual encroachment of 16 mm. projection upon the 35 mm. field is being made good with a vengeance. Small towns heretofore without movies are being combed by enterprising parties who are thinking in terms of not only a string of local chains but also state-wide combinations. One group we have in mind is even concerned with film production so as to insure a steady outlet to these small stands.

This development poses several interesting questions for projectionists, from both the technical and craft viewpoints. Operation of 16 mm. equipment with acetate stock is something quite different than professional 35 mm. theatre operation as we know it today. A little scratching beneath all these surface indications might not be a bad idea for those charged with steering the course of the craft.

REMINDER: The S.M.P.E. Fall Convention is scheduled for Detroit Oct. 31 to Nov. 2, inclusive. Those projectionists who can possibly make this meeting should do so.

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VOLUME XIII NUMBER 9

SEPTEMBER 1938

Common Causes of Breakdown in Theatre Sound Systems

By *AARON NADELL*

CONDITIONS leading to equipment breakdown generally give some advance warning, which, if correctly interpreted, make preventive measures possible and often easy. Breakdowns, do not of course, ever "just happen"; there must be a reason even in those exceptional cases where intensive investigation uncovers no logical reason therefore, and in the common run of events symptoms ranging from excessive temperature to poor sound quality provide notice that something is getting ready to give way and needs attention. A really thorough check of such signs can save not only the show but the cost of replacement parts or extensive repairs.

The causes of breakdown include natural wear or aging, unfavorable operating conditions and inadequate attention. If the things that happen to apparatus under those circumstances are thoroughly understood, the meaning of the advance symptoms shown is more readily apparent. The discussion that follows will take up, first, the details of what happens in the more common cases of breakdown, and then describe the symptoms that may be expected, and the precautions that should be taken.

Natural wear under common projection room conditions is probably the most usual cause of trouble even in the best-designed equipment. It may seem at first thought that electrical parts and wiring are under no mechanical strain and should, therefore, last indefinitely; but that is true only under ideal circumstances which do not prevail in projection rooms. In practice, amplifiers and other sound components must be made compact; therefore, they are subject to internal temperature rise despite the best possible ventilation. When the equipment includes a power transformer or other component that normally operates at elevated temperature (modern transformers may run very warm) this condition is exaggerated, and it is usually not the heat-producing part that gives way first.

Vibration is another factor, substantially absent in projection rooms having properly-constructed floors, but very damaging in others, particularly if a heavy motor associated with ventilation or the arc supply is incorrectly located or mounted. The effect of unsteady line voltage is also well known to practical projectionists.

● Construction a Factor

Other forms of what can fairly be termed natural wear or aging arise out of the design or construction of sound parts; it is no reflection on such parts that the best of them do not reach theoretical perfection. They are, in fact, remarkably sturdy, manufacturers having done amazing things in the past ten years toward eliminating the more conspicuous weaknesses. Nevertheless, exciter lamp filaments still lose their light-producing properties with time, and tube filaments do not continue to

emit a full quantity of electrons indefinitely.

Tubes are subject to slow leakage at the seals which in time make them "gassy." The insulating sleeve between

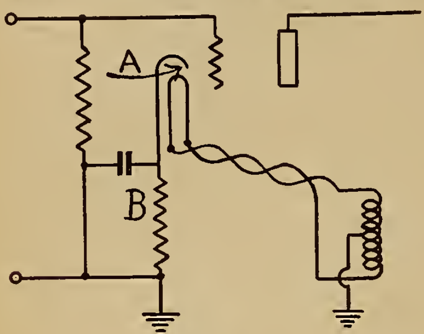


FIGURE 1

filament and cathode, in heater-type tubes, is subjected to great thermal strain, and momentarily to strong electrical strain. If the grid bias resistor (B in Fig. 1) punctures, it will be substantially short-circuited.

Trace from the upper end of that resistor through A, the presumed point of puncture, through the filament transformer to ground, and from ground back to the lower side of B. The resistance of B, which in some theatre circuits may run from one to several thousand ohms, is "shorted" by the low d.c. resistance of the filament transformer secondary. The grid of the tube is no longer negative with respect to cathode by the extent of the voltage drop through B, but, being practically at zero bias, permits a sharp increase in plate current that may do serious damage.

Filament-type tubes, which are not subject to this fault, sometimes substitute another: if the filament be long, as in a tube of large size, it is held under tension when hot by spiral springs, and these may lose their elasticity with age and prolonged exposure to high temperature, failing to keep the filament taut. But the filament is positive with respect to grid (see Fig. 2) by the extent of the space current voltage-drop in resistor B of that drawing; and opposite charges attract.

● **Tube, Condenser Troubles**

The slack left in the filament by failure of the springs to hold it tight is drawn toward the grid. At contact between them the grid bias is short-circuited, since the filament is now joined to the grid circuit at point A [Fig. 2] instead of at the opposite or lower end of resistor B. Since this condition is encountered only in the larger tubes, the resulting surge in plate current usually is very strong, often strong enough to require extensive repairs before the amplifier is restored to service.

Somewhat similar breakdown occurs in modern tubes through arc-over at the socket, or in the tube base where the connections come through the seal. The exact circuit derangements that follow depend on the location of the flash-over, which in turn varies according to the placement and spacing of the prongs, and the voltages and grounding arrangements of the equipment. Natural wear alone seldom produces much trouble, which is more usually occasioned by contributing factors, such as excessive line voltage, excessive volume, or both.

Condensers, like tubes, are subject to certain inherent shortcomings condenser troubles having been increased by resort to electrolytic forms as against the old paper or mica types. The electrolytics have conspicuous advantages: a trunkload of the old mica kind would be needed to provide as much capacitance as can be obtained from an electrolytic the size of a pack of cigarettes, and weight ratios are equally striking. But electrolytics, except for recent models, are likely to dry out, losing both their capacitance and self-healing properties. The best condensers of both kinds are the most modern versions of each, and condenser replacement is therefore strongly desirable at the first hint of trouble.

The older mica condensers included a fault of their own, in that they were frequently built into metal cases impregnated with pitch, and sometimes broke down when amplifier heat caused the pitch to leak or boil out. Such condensers still are in use. Modern improvements have eliminated the pitch and reduced size and weight to the point where the paper or mica unit is comparable with electrolytics of the lower ratings of capacitance.

Development of the electrolytic type has resulted in the practical elimination of water as the electrolyte and substituted high-boiling alcohols and similar compounds. Electrolytics so made are completely sealed and are immune to earlier forms of trouble. Their enormous capacitance, 25 microfarads or more for the bulk and weight that formerly provided only 1 microfarad, is largely responsible for the better sound quality of modern amplifiers.

Transformer failures are almost always the result of excessive heating, which bakes out the insulation. Operating temperature should not, however, be judged by hand, except through comparison with known operating conditions exhibited by the same unit in the past; modern transformers are likely to run much hotter than earlier models, and are built to stand up accordingly. Suspected overheating may be checked with a high-range thermometer (costing about two dollars) against manufacturer's ratings. A true and not deceptive case of excessive transformer temperature is an extremely serious matter, almost certain to cause breakdown, and should not be neglected even for an hour.

Resistors wear out through two causes, heat and friction. Friction, of course, operates only on resistance units serving as rheostats and potentiometers, and then only when these are often readjusted. Volume controls are most likely to go wrong from this cause, and always give warning before they do. Fixed resistors deteriorate through high temperature, which, over a period of time, tends to bake out the "binder" material of the carbon type, to weaken the wire of the wire-wound kind, and in either case may impair or break down moulded insulating forms on which such resistors are often mounted.

Contacts as used in sound equipment fall into two classes, fixed and temporary. The latter are usually made with solder, occasionally by nut and bolt only. Nuts loosen with vibration, of course, and soldered contacts are subject to weakening through a number of chemical causes, among which is the use of the wrong kind of flux in the case of projection room repairs. (Rosin is the only reliable flux to use on sound equipment.) Temporary contacts are rendered inoperative by dirt or by loss of spring tension, the latter occasionally being the indirect result of excessive temperature.

Dirt is a common cause of loss of contact in some types of tube and exciter lamp contacts, as well as in some forms of volume control. Loss of spring tension is also encountered in volume controls, but is less common in tube sockets. It is quite common in tube grid clips, that is, in those connections to grid wires that are brought

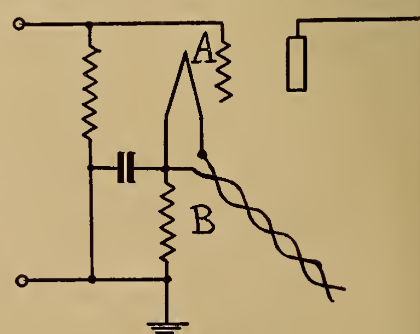


FIGURE 2

out at the top of many tubes rather than through the base.

Both dirt and loss of tension are found in key switches; the latter is often irreparable and calls for replace-

ment of the switch. A less common cause of poor contact may be found at the bases of some of the larger tubes, where dirt or poor tension has resulted in minute sparking that softens and deforms the solder tip at the bottom of the prongs.

● Sound System Wiring

Wire used for connections in sound apparatus deteriorates in several ways. The insulation (if impregnated cotton) may lose its protecting liquid by evaporation. Pitch protection is impaired in the same way, since usually some components of the material are volatile. When the evaporation is promoted by excessive operating temperature, the residual cotton will frequently char. Some forms of rubber insulation deteriorate naturally with age, and nearly all with heat. High temperature may also cause some of the sulphur in the rubber to unite chemically with the copper wire, forming a powder which is not a conductor and has no tensile strength. When conducting material is lost in this way, that which remains becomes hotter if any appreciable current is carried, promoting the process of destruction to a point where the wire burns through.

Insulation not directly associated with wires may be damaged through similar causes. Some forms of tube sockets are notoriously unable to stand up under excessive heating. The composition "wafer" sockets break down under excessive temperature, and this is true even of the Bakelite type, which in general weaken at around 300° Centigrade—572° Fahrenheit. Of course, no amplifier as a whole should get that hot, but some parts of every amplifier must; tube filaments are hotter. The design of the equipment, its location in the projection room, lack of exposure to free ventilation, etc., may confine the heat and cause it to build up.

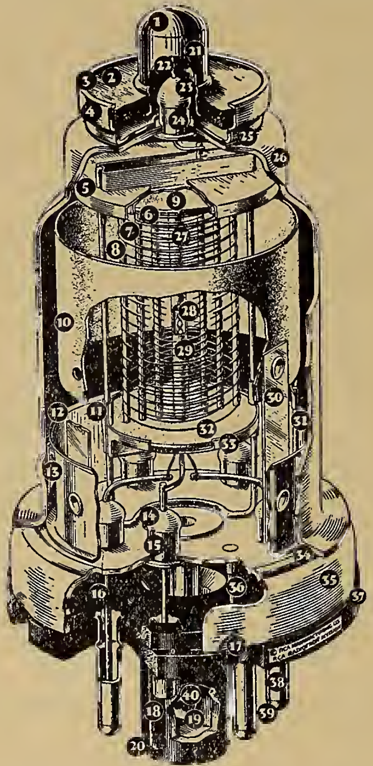
Speaker units are very subject to damage by vibration; it is their business to vibrate, at least as far as the cones are concerned. The wires carrying current to the moving coil must be thin and very flexible, so as not to impede its motion. The endless agitation of these wires occasionally causes them to break, sometimes makes them pull loose. Other parts of the speaker assembly may be loosened in course of time, particularly holding nuts, even when lock washers are used. In this way, connections are sometimes opened.

Mechanical friction as a cause of soundhead wear is obvious and need not be discussed herein.

● Warning Symptoms

Most of these faults give advance warning, permitting the use of suitable precautions. These may involve prompt replacement of the weakening component or advance order for a replacement part to be held on hand until the trouble threatens to become acute. Either procedure should always, when possible, be combined with immediate remedial steps. Some forms of breakdown are not subject to such precaution, being inherent in the design of the part, and giving little or no warning; in these cases selection of better replacements is the only permanent remedy.

FIGURE 3
Structural Details of an All-Metal (6J7) Tube



1—Solder
2—Cap Insulator
3—Rolled Lock
4—Cap Support
5—Grid Lead Shield
6—Control Grid
7—Screen
8—Suppressor
9—Insulating Spacer
10—Plate
11—Mount Support
12—Support Collar
13—Getter Tab
14—Glass Bead Seal
15—Eyelet
16—Lead Wire
17—Crimped Lock
18—Aligning Key
19—Pinched Seal
20—Aligning Plug
21—Grid Cap
22—Grid Lead Wire
23—Glass Bead Seal
24—Eyelet
25—Brazed Weld
26—Vacuum-Tight Steel Shell
27—Cathode
28—Helical Heater
29—Cathode Coating
30—Plate Insulating Support
31—Plate Lead Connection
32—Insulating Spacer
33—Spacer Shield
34—Shell-to-Header Seal Weld
35—Header
36—Shell Connection
37—Octal Base
38—Base Pin
39—Solder
40—Exhaust Tube

Common Tube Troubles

28-29: Cathode-filament insulation punctures. 15-16: Inter-electrode arc-over. 14, 19: Seals leak. 10, 26, 32: Shell and elements release occluded gases. 21: Connection loosens. 39: Solder deforms (some tube types). 6, 28: Filament-grid 'short' (some types).

Filament-to-cathode puncture, for example, the circuit effects of which are illustrated in Fig. 1, often gives no warning at all. Occasionally, however, there may be preliminary unsteadiness in the operation of the tube. A heater tube which gives any such indication, however slight, should be removed from service instantly, and not kept as a spare, but destroyed. Tubes are much too inexpensive now to justify risking amplifier breakdown. The momentary unsteadiness is caused by pin-point leakages through the cathode insulating sleeve.

Tubes of identical type number and operating characteristics, but products of different manufacturers, may have very different degrees of resistance to this form of trouble. Past experience, plus manufacturer ratings of cathode resistance, must be the guide to selecting the make most suitable for any particular socket.

A gassy tube also sometimes gives warning, and sometimes comes suddenly. A mildly gassy condition which does no other harm is not cause for rejecting a tube, since evacuation is never perfect. But if the condition grows worse daily that is a different matter: there is a slow leak, and the tube should be discarded without delay. Filament springs in some large tubes need watching when a cold amplifier is turned on at the beginning of the day. Any tube that ever shows the most momentary internal sparking should be discarded instantly.

Arc-over at the socket is often detectable by examination, since there is often a preliminary period of charring. Both upper and lower surfaces of the socket should be examined, if the design of the equipment renders them visible, monthly or more often. Most theatre equipments are so built that sockets subjected to high voltage are accessible for inspection. Charring of any kind calls for a new socket.

Early type pitch-insulated condensers, in which the pitch has boiled out or leaked to any appreciable degree, should be replaced, preferably by later models. Slow increase in line frequency hum over a period of time, in equipment using old-type electrolytic condensers, probably indicates that replacement is in order. Gradual loss of low-frequency response suggests replacement of electrolytic by-pass condensers.

An unexplained fuse burnout in equipment using condensers of any kind may have been caused by momentary puncture, which healed itself, and condensers so located in the circuit that they may have been responsible should be suspect. If they are of earlier style, replacement deserves consideration; repetition of such occurrences under such

(*Continued on page* 30)

Emergency Measures Applicable to Motor Control Failure

By *LAWRENCE BORGESON*

ELABORATE devices for controlling the speed of motion picture projector motors are now obsolete. Yet, today, there are many of these units being used in theatres throughout the United States. One type of controller, the W.E. 708-A control cabinet, has proven to be a very dependable piece of apparatus. There are times, however, when even the best mechanical and electrical devices fail, and it is at such a time that the projectionist needs information to enable him to repair or temporarily replace the defective unit.

This article will describe emergency measures of operation, and, in addition, discuss the normal function of certain components of the 708-A control cabinet.

Figure 1 shows a portion of the schematic usually supplied with the cabinet. All parts have been deleted except those pertinent to this discussion. Fig. 2 is a representation of the motor circuits. Fig. 3 shows the actual position within the cabinet of the various units under discussion.

● Motor Operation

In Figs. 1 and 2 the winding marked "stator" represents the stationary coils of the projector motor, while the winding marked "rotor" is a representation of those coils in the motor which revolve when the machine is in operation. Inspection of these figures reveals that the stator is connected directly to the 110-volt a.c. power line when the m.p.m. switch is in the operating position.

The a.c. flowing through the stator winding causes an alternating magnetic field to be set up which cuts the rotor windings and hence, induces a voltage in them. This induced voltage causes a potential difference to exist between terminals 3 and 4 (shown just to the right of the rotor in Figs. 1 and 2, and at the bottom of Fig. 3) and the rotor. This rotor current sets-up a magnetic field which opposes that of the stator, thus producing a force which causes the motor to revolve.

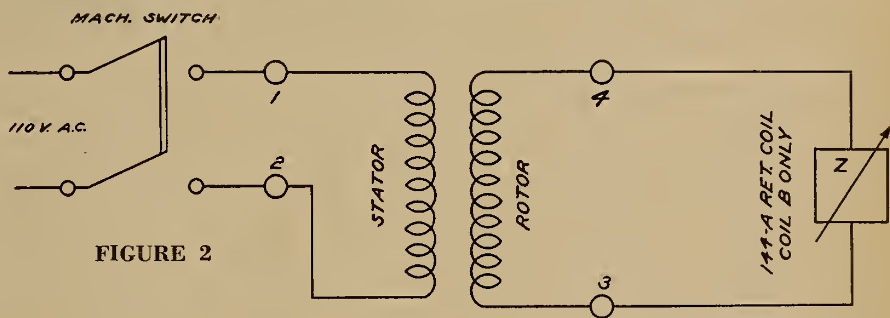


FIGURE 2

The motor may be thought of as a transformer, where the stator may be considered the primary winding and the rotor the secondary winding. In this case the secondary winding (the rotor) is free to move under the influence of magnetic forces; whereas, in the case of the usual voltage transformer the primary and secondary are fixed in their relation to each other. and only an excessive short-circuit will cause relative motion between them to any appreciable extent.

The motor speed is dependent, in part, upon the magnitude of the rotor current, which in turn depends upon the impedance of coil B of the retard coil L-2 (shown as Z in Fig. 2). It is the function of the various circuits of the control cabinet to keep the impedance of coil B at such a value that the rotor current, and hence the rotor torque, will maintain a motor speed of 1200 r.p.m.

The impedance of coil B increases or decreases, as need be, when the motor speed rises above or falls below normal. The value of this impedance (Z) is given by equation (1):

$$(1) \quad Z = \sqrt{R^2 + X^2} = \sqrt{R^2 + (2\pi f L)^2} \text{ ohms}$$

where,

R = resistance of L-2 between terminals 1 and 2, *i.e.* resistance of coil B.

X = inductive reactance, in ohms, between terminals 1 and 2 of L-2 (coil B).

f = frequency of rotor current c.p.s.

L = inductance in henries of L-2 between terminals 1 and 2 (coil B).

In (1) R and 2π remain constant regardless of motor speed, but both f and L change with the rotor speed. The value of L, in henries, is given in the following equation:

$$(2) \quad L = \frac{4\pi N^2 uA}{10\ l} \times 10^{-8} \text{ henries}$$

where,

N = number of turns of wire on coil B

A = area of magnetic path of coil B (assumed constant)

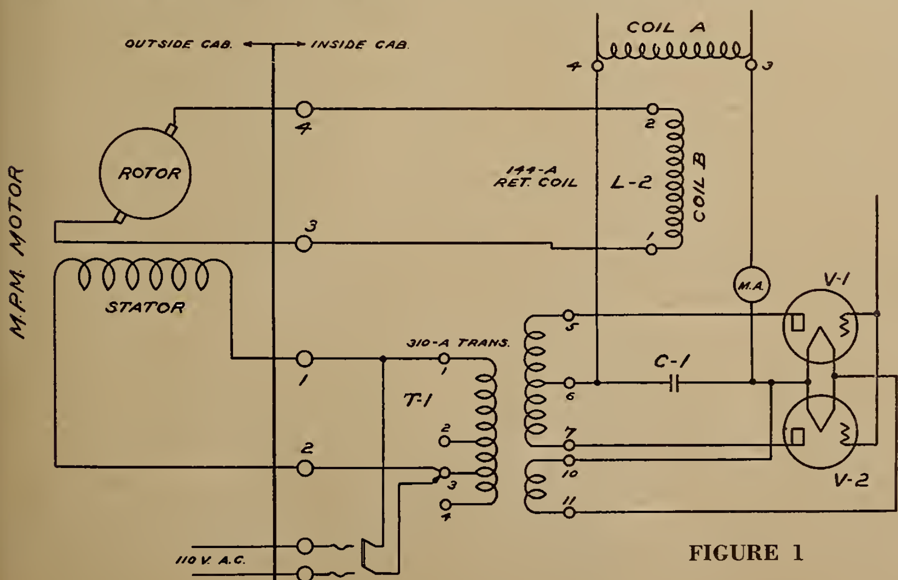


FIGURE 1

1 = length of magnetic path of coil B (assumed constant)

u = permeability of magnetic path of coil B.

Combining equations (1) and (2), we get equation (3).

$$(3) \quad Z = \sqrt{R^2 + Kf^2u^2}$$

where,

$$K = \frac{16\pi^4N^2A^2}{25\ l^2}$$

Since N, A, and l remain unchanged at all times, an inspection of equation (3) discloses that it is the permeability of the core which must be changed to cause a resultant change in Z and the rotor current. Now, the permeability of iron and steel decreases as the magnetization increases; that is, when the metal is highly magnetized u is much lower in value than is the case if the metal is nearly unmagnetized. Fig. 4 shows the relation between the magnetizing force and the permeability for a specimen of annealed sheet steel such as is commonly used for core laminations.

The core of L-2 is so arranged that the iron core serves as the magnetic path for both coil A and coil B (Fig. 1). Hence, if there is a large current through coil A, the common portion of the magnetic circuit is highly magnetized, u is therefore relatively low, as is the inductance and impedance of coil B. This causes the impedance of the rotor circuit to be low, the rotor current to be high and the speed of the motor to be high.

Conversely, when the current through coil A is small, the motor speed is low. Approximately all of the current flow indicated by the milliammeter on top of the control cabinet flows through coil A. This meter reading is high (60 to 80 ma.) when the motor is accelerating, thus allowing the rotor current to also be high. When 1200 r.p.m. is maintained, both of the aforementioned currents are much lower.

When the motor speed exceeds 1200 r.p.m., the circuits of the cabinet act to decrease the current in coil A, thus increasing u and therefore Z, which causes the rotor current to be diminished and likewise the motor speed. At time of starting, the current in coil A is high and Z becomes so low in value that the rotor is practically short-circuited until 1200 r.p.m. is reached.

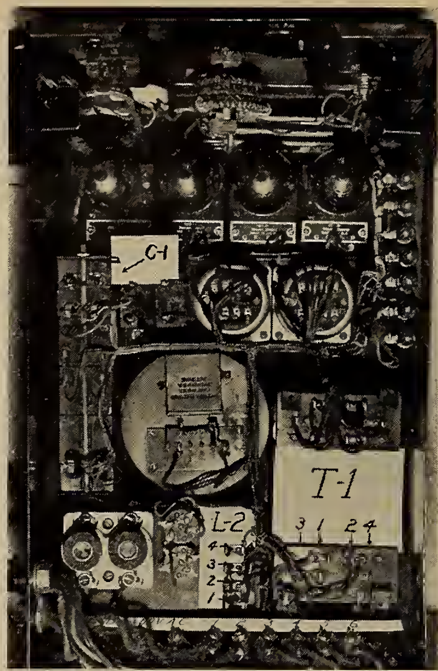


FIGURE 3

When some vital part of the apparatus fails, the projectionist usually finds that the motor either runs extremely fast or extremely slow, with the milliammeter showing a high reading in the former case and a low reading in the latter. Bad tubes, or poor tube-prong contact, can cause this type of trouble, and these possibilities should always be checked first. However, if it is determined that some major trouble exists such as a burned out power transformer, *etc.*, then it is necessary to resort to some emergency method of operation.

From the foregoing discussion we readily see two methods of attack. First, we can supply an external impedance of some sort to do the work of coil B; or second, we can use an external power source to supply the current to coil A.

● Method 1: Resistance

If a resistance is placed across the rotor circuit, in parallel with coil B, it is possible to operate the motor at normal speed. The resistance must have a value of approximately one ohm. The exact value required to give a motor speed of 1200 r.p.m. differs for various installations, but in most cases will be between 0.8 and 1.2 ohms. It is necessary that the resistance be able to carry 15 amperes, *i.e.*, it must be able to safely dissipate at least 225 watts.

In order that the motor come up to speed in a reasonable length of time (4 to 7 seconds) it is necessary to "short" the rotor until normal speed is reached. This can be done by placing a s.p.s.t. switch across the external resistance used. The manner of making the connections is as follows:

1. Remove all tubes from the control cabinet.
2. Connect the external resistance to be used to terminals 3 and 4 on the terminal strip inside and at the bottom of the cabinet (see Figs. 3 and 5). In Figs. 5, 6, and 7 the fine lines indicate normal circuits and the heavy lines indicate added emergency circuits.
3. Connect a s.p.s.t. shunting switch between terminals 3 and 4; *i.e.*, directly across the rotor as shown in Fig. 5. The snap switch on top of the control cabinet may be used for this purpose if it has been permanently cut out, as is the case in many theatres.
4. If, on attempting to operate, trouble is experienced (such as excessive heating of some unit in the cabinet) it will be necessary to disconnect the power transformer (shown

FIGURE 4

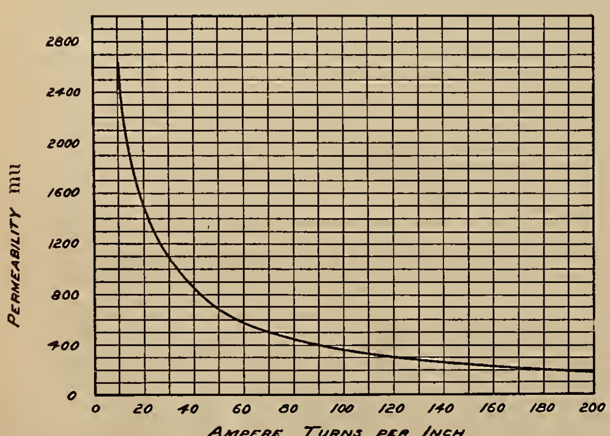
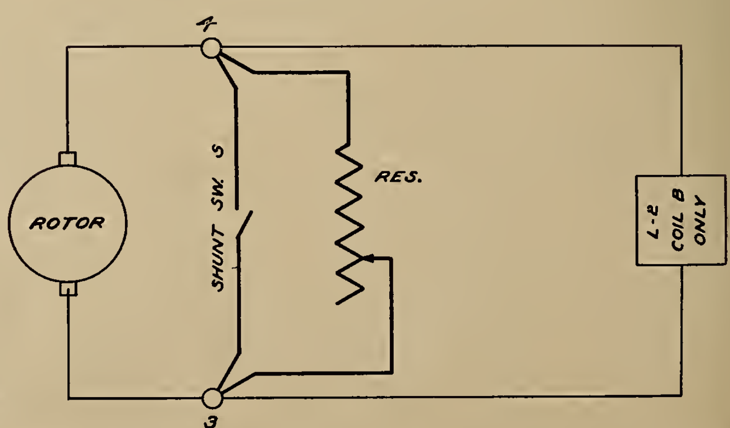


FIGURE 5



as T-1 in Figs. 1 and 3) from the 110-volt a.c. line. This is accomplished by removing the two wires from terminal 1 of T-1. These two wires should

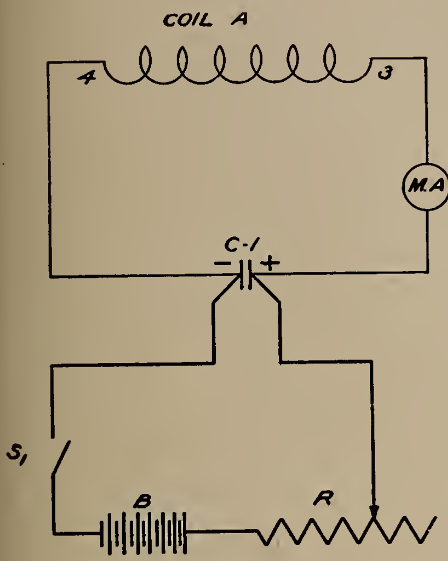


FIGURE 6

then be soldered together and taped. If trouble still is experienced (not likely) it will be necessary to also remove the two wires from terminal 2 (or 3 or 4, whichever terminal is being used), and these should also be soldered together and then taped. This procedure completely eliminates the 110-volt a.c. from the control circuits.

An arc ballast resistor, if of sufficient resistance and proper current rating, serves admirably in this method of operation. The wires from terminals 3 and 4 can be connected to the ballast by means of battery clips. This allows for rapid determination of the proper amount of resistance to give a speed of 1200 r.p.m., since the clips can be moved from coil to coil or grid to grid of the resistor until normal speed is obtained.

A lighting dimmer is a type of resistance which is often available and may be used for controlling the rotor current. The dimmer can be removed from its circuit and placed across the rotor at terminals 3 and 4. By adjusting the control lever the necessary amount of resistance is obtained.

After all connections and adjustments are made, the operating procedure is as follows:

a. Be sure shunting switch S of Fig. 5 is closed at some time before the changeover is to be made.

b. Start motor in the normal manner by closing the machine switch.

c. When motor reaches 1200 r.p.m. open switch S.

The machine will then run without further attention. The motor is stopped in the usual manner, but the projectionist must remember to close the shunt switch S before the machine is started again.

Method 2: Battery or Arc Generator Operation

Emergency operation can be effected by supplying d.c. current to coil A of Fig. 1 from some outside source, such as the d.c. arc supply or batteries. When the control cabinet acts in a normal manner, there is a voltage of approximately 180 across coil A at terminals 3 and 4 of L-2 (see Figs. 1 and 3) during the period of acceleration. When the motor is operating at 1200 r.p.m., the voltage across this coil is approximately 70.

If two 90-volt "B" batteries are available, at the time of control cabinet failure, they can be connected in series to give 180 volts. By making wiring connections as shown in Fig. 6, it is possible to operate the projector in a satisfactory manner. "B" represents the batteries, S_1 is a s.p.s.t. switch for disconnecting the batteries from coil A when the projector is idle. R is a variable resistance of from 12,000 to 15,000 ohms. A radio potentiometer or volume control is excellent for this purpose and may be purchased at any radio parts supply store for about fifty cents.

It will be noted in Fig. 6 that the connections of the batteries and resistance are made at condenser C-1 (see Fig. 3) instead of at the terminals of coil A of L-2. This is done in order that the milliammeter on the top of the control cabinet will indicate the current in the coil, thus aiding the projectionist in adjusting the speed of the projector. As in the previous method discussed, the vacuum tubes should be removed, and, if necessary, the connections on T-1 should be taken off, soldered together and taped as explained previously.

If the failure was such that the foregoing will not operate satisfactorily, it will be necessary to remove the wires from terminals 3 and 4 of L-2, and if this is done, the connections from the external power source will have to be made at terminals 3 and 4 of L-2 rather than at condenser C-1. The operating procedure with this arrangement is as follows:

a. Close switch S_1, Fig. 6, a short time before the changeover is to be made.

b. Have R set so that all the resistance is cut out, *i.e.*, coil A is directly across the batteries.

c. Start machine motor as usual at the time of changeover.

d. When machine reaches a speed of 1200 r.p.m., adjust R, cutting in resistance, until the milliammeter reads correctly for normal operation.

The machine is shut down in the usual manner, but S_1 should be opened while the second projector is running in order to reduce the drain on the batteries.

Use of Arc Supply Voltage

If d.c. power is available in the projection room of a voltage greater than 180 volts, this source may be used instead of batteries. The wiring will be identical with that shown in Fig. 6 with the two following exceptions: first, the d.c. arc power lines replace the battery, and second, the resistance of R should be of a value given by equation (4):

where,

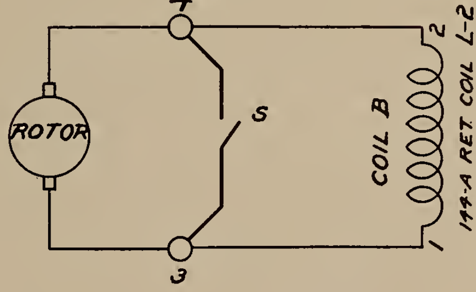
(4) $R = 67\ E$ ohms

E = arc power line voltage

R = the resistance of the rheostat (potentiometer or radio volume control)

If the line voltage is much greater than 180 volts, the resistance R should not all be cut out in operating procedure (b) above, but should be adjusted to give a reading of the milliammeter of from 65 to 70 ma.

If the arc supply voltage be from a generator, it will probably be of a value of 110 volts or less. If this is the case, the temporary connections should be made as shown in Fig. 7, where



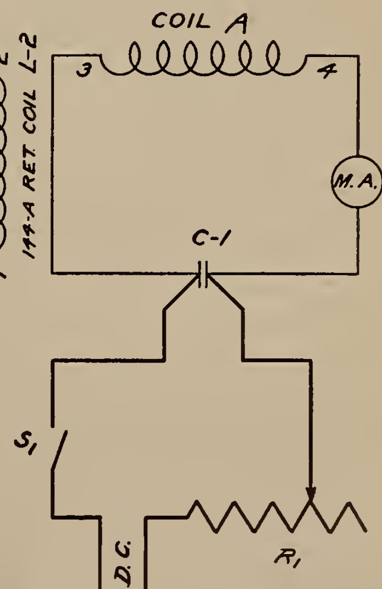


FIGURE 7

S_1 is a s.p.s.t. switch for disconnecting coil A from the arc supply voltage. S is a s.p.s.t. switch for "shorting" the rotor circuit on starting, in the same manner as was discussed in method 1. R_1 is a resistance (potentiometer or radio volume control) of resistance given by equation (5).

$$(5)\quad R_1 = 1.25 \left(\frac{E}{I} - 2500\right) \text{ ohms}$$

where,

E = d.c. generator voltage

I = normal reading of control cabinet milliammeter when projector speed is 1200 r.p.m.

R_1 = resistance of potentiometer or volume control used.

For example, suppose the arc generator voltage is 70, and the control cabinet milliammeter normally reads 20 ma., then a potentiometer of $1.25 \left(\frac{70}{.020} - 2500\right) = 1250$ ohms should be used.

R_1 is adjusted so as to cause the motor to run at 1200 r.p.m., and after once being set, probably will not require additional adjustment. The procedure for operating using these connections is as follows:

a. Close switch S at some time before the changeover is to be made (Fig. 7).

b. Close switch S_1 a few moments before the changeover is to be made.

c. Operate the machine motor switch in the normal manner when the changeover is made.

d. When motor reaches 1200 r.p.m. open switch S.

The motor will then run normally. As in the previous arrangements, the vacuum tubes should be removed, and it may also be necessary to disconnect T-1 from the 110 volt lines.

Each of the methods has its advantages and disadvantages. Both are somewhat inconvenient to use, but they do offer a means of continuing the performance in a manner which will appear normal to the audience. Method 1 can be very satisfactory, but in some cases where dimmers are used, speed control is somewhat difficult due to the relatively large change in resistance between successive steps. Method 2 offers a means of speed control which will allow for extremely fine adjustment.

The projectionist who is familiar with the normal operation of the control cabinet and who is able to apply either of the emergency measures in case of failure, will never have to fear prolonged interruption of a performance, nor will he find it necessary to run on one machine until he obtains outside aid.

Notes on Time-Lag in Gas-Filled Photo-Electric Cells

By *A. M. SKELLETT*

MEMBER, TECHNICAL STAFF, BELL TELEPHONE LABORATORIES

When a gas-filled photoelectric cell is suddenly illuminated, the current through it increases very rapidly at first but attains its maximum value after only about a thousandth of a second. Likewise, when the light is abruptly extinguished some current flows through the darkened cell for about the same brief interval. This delay has been ascribed to the time required for the gas ions which are generated in the tube to move to the cathode.

The failure of the output to follow the light variation exactly can be explained readily on this assumption at frequencies of about 10,000 cycles; but considerable doubt has been expressed that the lag at lower frequencies could be due to the same cause.

The current in a gaseous cell involves not only the electrons which the light liberates at the cathode but also all the other electrons and ions which these photoelectrons produce in collision with gas molecules. Thus for each primary photoelectron liberated at the cathode, a number of electrons arrive at the anode. The positive ion formed at each ionizing collision travels in the opposite direction toward the cathode, but moves much more slowly through the gas because of its larger size and mass.

Special P. E. Cell Used

In studies in gas-filled cells, commercial designs are not particularly suitable, mainly because in them the electric field is not uniform and hence some ions take longer to reach the cathode than others. The design shown in Fig. 3 overcomes this defect, for its anode is small and all parts of the cathode are approximately equidistant from it. As a consequence of this geometrical form, the electric field is distributed uniformly throughout the entire tube as shown in Fig. 2, and the transit time of all the ions is approximately the same.

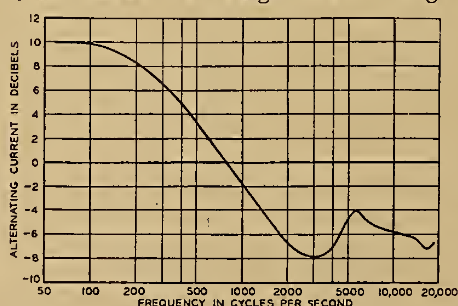


FIGURE 1

The magnitude of the alternating current output of the cell varies with the frequency of the incident light because the components of the current carried by the electrons and the gas ions are in phase at only certain frequencies

If the photo-sensitive cathode is illuminated by the light whose intensity varies sinusoidally, the emission of the primary photoelectrons and the consequent production of positive ions will also vary sinusoidally. Waves of ions will travel from the region of the anode to the cathode, slowing up as they approach the cathodes like ocean waves rolling in on a sandy beach.

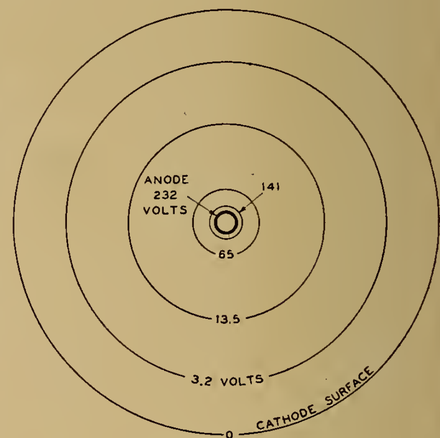


FIGURE 2

The symmetrical construction of the photo-electric cell gives a uniform distribution of the electric field within it

Now, it so happens that the current in the external connecting circuit due to the transit of a charged particle across the cell flows during the whole time the particle is in motion, ceasing when it delivers up its charge on reaching an electrode. Furthermore, most of this current flows while the particle (ion or electron), is in the vicinity of the anode and is moving swiftly. The electrons get across the cell very quickly and the ions get out of the vicinity of the anode in a very short time, so that most of the current due to a photoelectron and to the electrons and ions it produces, flows almost instantaneously in the external circuit.

When the ions reach the cathode they

release new electrons, which, like the original photelectrons, produce new ions and electrons and cause another pulse of current to flow. The second pulse flows after a time interval which is approximately equal to the transit time of the ions, and succeeding pulses of decreasing amplitude follow at intervals equal to this. Thus if the release of photoelectrons varies sinusoidally, a series of sinusoidally varying currents will flow in the external circuit. These will all be in phase when the transit time of the ions is equal to the period of the current variations, for then the crests of the waves fall together and the total alternating current output is a maximum. Conversely, when the transit time of the photoelectrons is equal to half a period, the total current falls to a minimum value.

By measuring the magnitude of the output of the cell for different frequencies of light variation and plotting the data, Fig. 1, the first minimum and subsequent maximum are found to occur where expected on the assumption that the effect is due to the relatively slow velocity of the gas ions. Other maxima and minima might be anticipated at higher frequencies, for which the times of flight would be multiples of the periods and half periods. They are not

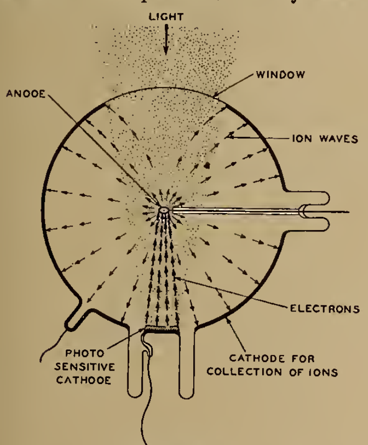


FIGURE 3

A special photoelectric cell was constructed for the time-lag tests. The anode is small and all parts of the cathode are approximately equidistant from it

observable, however, because the ions move about in a very irregular manner, with the result that at the higher frequencies individual ions wander from their positions in the wave, the crests and troughs merge, and the waves lose their identity.

It is possible to calculate, from the speed at which argon ions drift, what the average velocity of the ions at different distances along the radius should be; and to deduce therefrom the total time taken by an ion in going from the vicinity of the anode to the cathode. As stated in the preceding paragraph, the value thus determined is the same as the period of the light frequency at the first maximum, or half the period at the first minimum. This confirms the theory given above and thus establishes the nature of the time lag in this cell.

In commercial cells large variations in the time delay are to be expected because of their non-uniform fields, mentioned previously. Thus the fact that maxima and minima have not been observed in curves taken with commercial cells of usual design is reconcilable with the theory that has been developed. But the lag in response is there just the same.

For the voice-frequency band used in sound pictures the distortion caused by the lag in the photoelectric cell is not serious. There is some phase distortion, but fortunately the ear cannot detect it. The most obvious practical consequence of the lag is a small loss in efficiency which, now explained, could be reduced if necessary by modifying the cells. Where frequencies much above 10,000 cycles are involved, the lag becomes large and has to be taken into consideration in the design of cells.

Notes on S.M.P.E. 16-mm. Test-Films

SEVERAL years ago the Society made available to the industry, as a development of the Projection Practice Committee, a visual and a sound test-film on 35-mm. film. In view of the rapid expansion of the 16-mm. industry, a need was felt for similar films in the 16-mm. size. Accordingly, arrangements were made by the Society to supply optical reduction prints of the 35-mm. visual test-film.

The visual test-film consists of the following test-targets, each preceded by a title stating the purpose for which it is intended, arranged in the following order:

(*a*) Small diamonds and vertical bars arranged alternately in rows for checking travel-ghost.

(*b*) Small squares arranged diagonally across the frame, for checking picture jump and picture weave.

(*c*) Fine vertical lines closely spaced, for checking marginal and radial aberration of objective (projection) lens.

(*d*) Fine horizontal lines closely spaced, for checking marginal and radial aberration of objective (projection) lens.

(*e*) Small squares for checking best focal position of objective lens.

Complete instructions for making these tests are available from the Society, which apply equally to the 35-mm. and 16-mm. size. The 16-mm. visual test-film is printed on acetate stock and is about 400 feet long.

At the same time there arose in the 16-mm. industry a need for a sound test-film similar to the one already prepared for the 35-mm. industry. Accordingly, when the time came to prepare a new 35-mm. negative, provisions were made to record at the same time a 16-mm. version identical to the 35-mm., except with respect to the range of frequency recorded. It was not thought advisable to record in the 16-mm. film frequencies higher than 6000 cycles, whereas frequencies up to 10,000 were included in the 35-mm. version. Also, the buzz-track frequencies for the 16-mm. film are 3000 and 5000 cps., whereas for the 35-mm. film they are 6000 and 9000. In other respects, the contents of the two films are identical. The contents of the 16-mm. film are as follows:

(*a*) Buzz-track for checking the position of the scanning beam relative to the sound-track.

(*b*) 3000-cycle and 5000-cycle notes for checking the focus and rotational adjustment of the sound optical system.

(*c*) Selected frequencies, including 50, 100, 200, 300, 500, 1000, 2000, 3000, 4000, 5000, 6000 cycles for ascertaining the overall output characteristics of sound-heads and amplifiers. This track was recorded at constant level in order to avoid voltage calibration when a volume indicator is used. In listening, the 1000-cycle note will sound louder than the others, because the normal ear is more responsive to notes of that frequency than to higher or lower notes. This track may be used to check the range of frequency covered by the equipment.

(*d*) Speech recordings for checking intelligibility of speech and theatre reverberation.

(*e*) Piano recording for checking flutter and "wows."

(*f*) Orchestral recording for checking naturalness of reproduction.

The 16-mm. sound test-film is printed by optical reduction from a special 35-mm. negative pre-corrected so that in the section of selected frequencies (50-6000 cycles) the levels at the various frequencies will always be the same, except at 6000 cycles, which is —2 db. This makes voltage calibration unnecessary when a volume indicator is used in making measurements on equipment. If the frequencies are reproduced by an ideal reproducer, the output readings will then be constant except, as noted, at 6000 cycles. The negative track is of the variable-width type, recorded with ultraviolet light.

In view of the fact that there is only one row of sprocket-holes in the 16-mm. film, there is one continuous sound-track, making the film approximately 400 feet long; whereas in the 35-mm. size the sound-track is divided into two parts, one part next to each row of sprocket-holes. The 35-mm. film must then be run through the reproducer twice in opposite directions to play it completely.

The Theory of Commutation

By ENGINEERING DEPARTMENT, NATIONAL CARBON COMPANY

II.

IMMEDIATELY before and after the short-circuited period the coil is carrying full armature load current. Consequently, it is necessary that there be some means of suppressing the current flowing in the coil at the time it is short-circuited and re-establishing a current of like value in the opposite direction before the short-circuit is broken. If this is not done, the sudden rush of current, when the short-circuit is broken and load current forced through the coil, will cause an arc to be drawn between the brush and the commutator segment which is passing from under it. This phenomenon is known as "sparking."

The reversal of current in the coil undergoing commutation is complicated by the property of inductance. Any coil of wire resists a change in the value of the current it is carrying, the amount of this resistance depending on the physical characteristics of the coil itself, the magnetic permeability of adjacent material and the time rate at which the current changes.

A clearer conception of this electrical characteristic, called inductance, may perhaps be obtained by considering its mechanical analog, inertia. A mass, because of its inertia, resists either increase or decrease of its velocity, and that resistance is proportional to the rate at which velocity is changed.

Likewise, an inductive electrical circuit resists any change in value of the current it is carrying. This opposition takes the form of a counter E.M.F., that is, a voltage having a direction which resists the change taking place. In the case of the commutating armature coil this counter E.M.F. is known as the reactance voltage. Methods used to overcome the reactance voltage and accomplish the reversal of current without sparking will be considered subsequently in this discussion.

● Distortion of Magnetic Field

Up to this point we have not considered the magnetic efforts of the load current flowing in the armature conductors. It was seen in Fig. 9 that the armature conductors adjacent to the north pole of the field are carrying current away from the observer, and those near the south pole, toward the observer. The effect of these armature cross ampere-turns is to establish a magnetic flux at right angles to the main field, having a direction downward, as shown in this drawing, and varying in strength with the current flowing through the armature.

The resultant flux no longer flows directly from north to south pole with uniform distribution over the pole faces, but is distorted by an amount depending on the strength of the armature current. This results in lowering the flux density under the leading pole tips and increasing it under the trailing tips. This crowding of flux at the trailing tips is illustrated in Fig. 10. This figure also indicates the increased "fringing" which occurs at the trailing tip as a result of the crowding of flux to that point.

For further simplicity in drawing, the commutator has been omitted in this figure and the brushes are shown bearing directly on the armature core. Due to the omission of the armature end-windings the neutral point for the brushes in a drawing of this type is half way between the poles, instead of at the center of the pole faces, as in practice, and as indicated in Fig. 9.

With the field flux distorted by the armature current, a coil short-circuited by a brush in the mechanical neutral position is no longer free from E. M. F. This is because it is no longer moving parallel to the flux, but is cutting through it to some extent. To overcome this condition, which would result in heavy current in the short-circuited coil, the brushes are shifted forward until commutation takes place at a time when the sides of the coil are moving parallel to resultant flux. In fact, the brushes should be shifted slightly beyond this electrically neutral point so that an E. M. F. will be generated to counteract the reactance voltage and aid in the reversal of the current in the coil.

The angle by which the brushes are shifted ahead of the mechanical neutral position is called the angle of lead. This

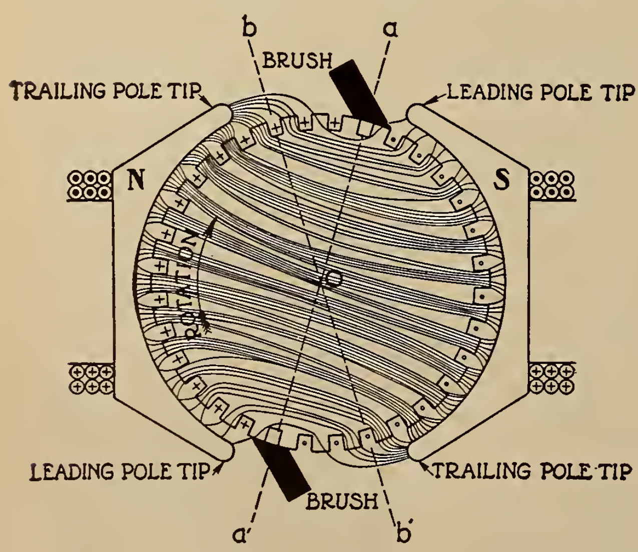


FIGURE 10
Diagram illustrating field distortion

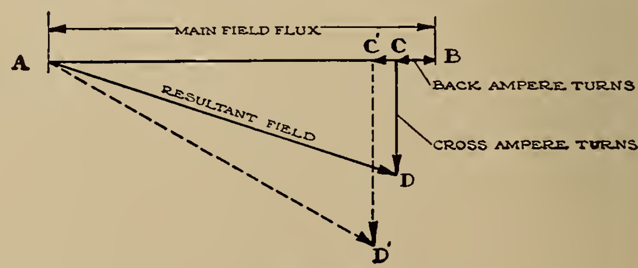


FIGURE 11
Vector diagram of field flux

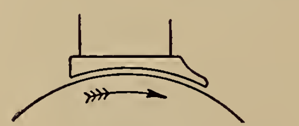


FIGURE 12
Pole shoe with thin trailing tip to limit shifting of field by saturation of tip

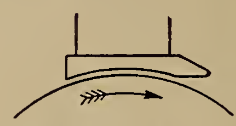


FIGURE 13
Pole shoe with face beveled at trailing tip to limit shifting of field by increasing reluctance of air gap

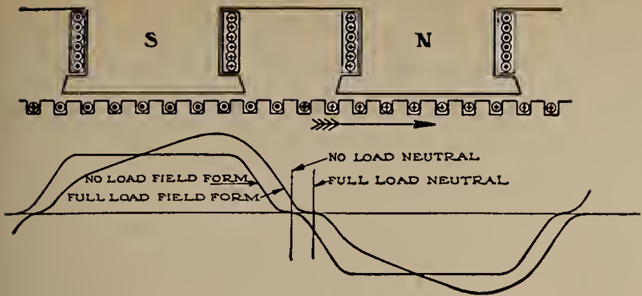


FIGURE 15

Form of magnetic field on non-interpole generator

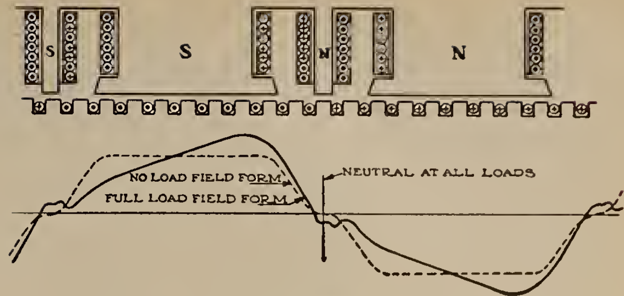


FIGURE 16

Form of magnetic field on interpole generator

position is represented by the line *aa*' in the figure. If we draw line *bb*' at a corresponding angle behind the neutral position, the angle *aob* is called the double angle of lead. It will be noted that, as the brushes are shifted, the direction of current in the armature conductors is advanced at the same time. As a result the current is no longer balanced in all the conductors at the top and bottom of the armature, but those conductors included within the double angle of lead, *aob* and *a'ob'*, tend to establish a magnetic flux directly opposed to the main field. This magnetomotive force is called the back ampere-turns. The cross ampere-turns are now confined to the conductors within the angles *aob'* and *a'ob*.

The strength and direction of the resultant flux may be indicated more clearly, perhaps, by means of the vector diagram in Fig. 11. Here AB represents the strength and direction of the main field; BC, the back ampere-turns; CD the cross ampere-turns, and AD, the resultant flux through the armature. It is apparent that increase in armature current will increase both BC and CD, as indicated in the figure by BC' and C'D', and will result in a reduction, as well as a further distortion, of the resultant flux. For this reason a generator that is required to maintain constant voltage under all loads is provided with a compound field winding.

In addition to the shunt field winding, that is, the winding connected across the terminals of the armature, there are a number of turns on the field poles in series with the armature and carrying load current. These counteract the effect of the back ampere-turns on the armature and hold the magnetic flux, and consequently the voltage, up to its full value. By putting on enough series turns the voltage of the generator may even be increased with increase in load. This is called over-compounding. However, compounding does not counteract the cross ampere-turns and so does not prevent distortion of flux direction.

In a motor the flux distortion under load is against the direction of rotation and the brushes, for best commutation, should be shifted back of the mechanical neutral. Except for direction, however, the effect of load current on field strength and distortion is the same as those which have just been described for the case of a generator.

● Reducing Field Distortion

It will be apparent that, where the distortion of the field is pronounced under changes of load, a machine will be very sensitive as to commutation, and shifting of the brushes may be necessary for slight changes in load if sparking is to be avoided. Many methods have been devised to overcome this fault and maintain good commutation over a wide range of load. All have, as a primary purpose, the reduction of field distortion. A few of these methods will be discussed.

One method is to use a long "air-gap" and a "stiff" field. The long air-gap produces a magnetic circuit of high reluctance, thereby minimizing the effect of the armature windings, while the strong field winding brings the main flux up to the necessary value.

Saturation of the trailing pole tip by various means, such as giving it a special shape, Fig. 12, is another means of preventing the shifting of the flux. If the pole tip is saturated, the flux through it will increase very little, no matter what magnetomotive force is applied. Beveling the tip so that the flux encounters a longer air-gap as it tends to shift, is a modification of this method, illustrated in Fig. 13.

A similar result is attained by the use of cast iron pole shoes. Cast iron has a much lower magnetic permeability than steel, and will become saturated with a slight shifting of the flux and thus oppose further distortion. By using a thin shoe of cast iron at the pole face the total reluctance of the magnetic path through the field is not greatly increased.

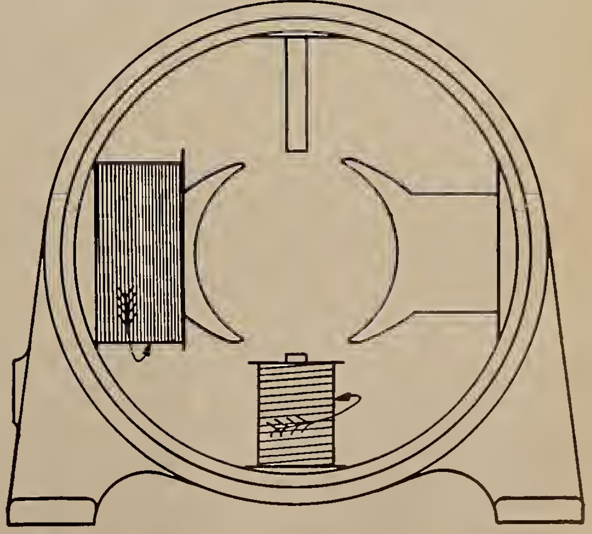
● Interpoles and Pole Face Winding

Undoubtedly the best method that has been devised for preventing field distortion and securing good commutation under all loads is the use of interpoles. These are small, auxiliary poles placed mid-way between the main poles and provided with a winding in series with the armature. Fig. 14 shows the frame of a two-pole, interpole machine, one main and one auxiliary pole being shown with winding in place and the others without.

The effect of the interpole flux is to oppose that due to the cross ampere-turns of the armature, thus offsetting the shifting of the direction of main flux and maintaining the neutral field zone in a fixed position. By making the interpole winding somewhat stronger than is necessary to counteract the armature

FIGURE 14

Field frame for 2-pole machine with interpoles. Direction of field currents shown for clockwise rotation of generator armature. Interpole precedes main field pole of like polarity on generator. Interpole follows main field pole of like polarity on motor



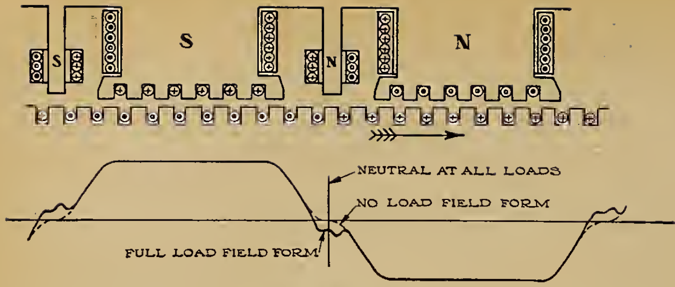


FIGURE 17

Form of magnetic field on interpole generator with compensating pole face winding

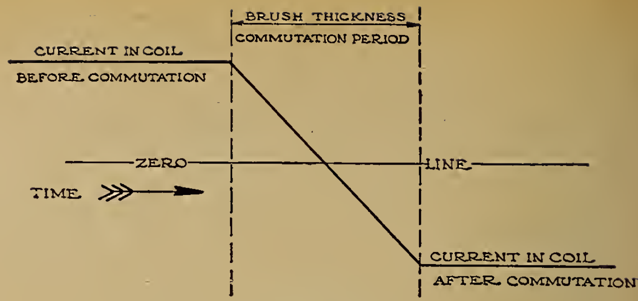


FIGURE 18

'Straight line' commutation

cross turns, it not only corrects field distortion in the commutation zone but induces a voltage in the coils undergoing commutation which neutralizes reactance voltage in these coils and accomplishes the reversal of the current in the coils before the short circuit is broken. Machines with properly designed interpoles can be operated sparklessly over their entire load range without shifting of the brushes, provided the core of the interpole is not saturated under heavy loads.

The effect of the interpole winding can be more readily understood by reference to the accompanying rectified curves of magnetic distribution.

● Flux Distribution

Fig. 15 illustrates the flux distribution of a non-interpole generator. Curves are shown for no-load and full-load. These show the crowding of the flux away from the leading to the trailing pole tip when the machine is loaded. They also show the shifting of the neutral or point of zero flux.

Fig. 16 shows similar curves for a machine with interpoles. It will be seen that the flux distortion immediately under the main pole faces still takes place as the load comes on, but the shifting of the commutating zone is eliminated by the interpole flux and the commutating point held stationary for all loads. The dip in the full-load flux distribution curve at the commutation point represents the extra flux necessary to neutralize the reactance of the commutated coil and reverse the current in it during the period of commutation.

The magnetomotive (magnetizing) forces existing in the parts of an interpole generator are composed of three elements: that in the main field, that in the interpole and that in the armature. It is the latter that causes the distortion of the flux under the main poles and is largely beyond the influence of the interpoles, except in the commutating zone. By distributing in slots on the pole faces a winding in series with the armature and of corresponding number of turns, but with current in opposite direction to that in adjacent armature conductors, it is possible to create a M.M.F. opposed to the armature M.M.F., and with the aid of the interpoles, almost perfectly compensate the effects of the armature winding. Fig. 17 shows the flux distribution in a compensated generator.

The value of the compensating pole-face winding lies in the reduction of the peak voltage which is generated in the armature coils when they pass through the distorted flux seen in Figs. 15 and 16. This high voltage per coil puts an added strain on the insulation, tends to produce ring-fire and may even lead to the machine flashing over. With distortion of the field flux under the pole faces eliminated by means of the compensating winding, the danger of such troubles is minimized, and a higher average voltage per armature coil becomes permissible.

In the case of crowded designs, such as high-capacity, 60-cycle rotary converters, where physical limitations must be approached as closely as possible, the compensating winding has made possible designs which otherwise could not have been attempted.

● The Commutation Period

In the study of commutation it should be borne in mind that perfect neutralization of voltages is seldom, if ever, attained in practice, although it might be implied from the foregoing discussion that such is the case. A given fixed voltage could be easily compensated, but the voltages in the commutating coil are undergoing change of value throughout the period of commutation. Perfect compensation would require that the time rate of change, as well as the average and maximum values, must be matched by the neutralizing voltage. If accomplished, we should then have "straight line" commutation, that is, the time-current curve for the short-circuited coil would be a straight line, as shown in Fig. 18, and the current density over the full thickness of the brush face would be uniform.

While straight line or linear commutation is very difficult to obtain, it is practicable to obtain a commutation curve approximating the sinusoidal curve shown in Fig. 19. Commutation on such a basis is very satisfactory, since the short-circuit current is reversed and re-established at load value before the short-circuit is broken.

It will also be seen from Fig. 20,

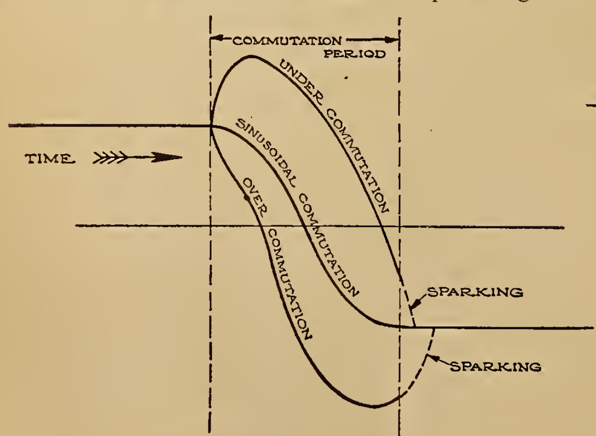


FIGURE 19

Types of commutation encountered in service

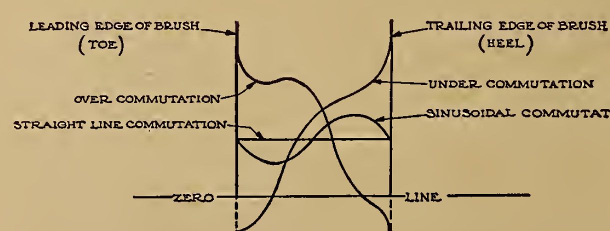


FIGURE 20

Curves of average local current density at brush face under commutating conditions shown in Figs. 18 and 19

which shows the average local current density across the brush face, that extreme densities are not encountered with sinusoidal commutation. If the compensating voltages are too weak, the condition known as under-commutation will be encountered. The current in a coil just short-circuited will increase for an instant before reversal begins, and will not be established at the reversed load value when the short circuit is broken. As a result, an arc or spark is drawn between the brush and the receding commutator segment while the current adjustment in the coil is being completed.

Over-commutation, by establishing too large a reversed current in the commutated coil, likewise produces sparking when one of the connected commutator bars moves from under the brush. Typical short-circuit current curves for under- and over-commutation are shown in Fig. 19. In Fig. 20 it may be seen that, with under-commutation, the current is reversed at the leading edge of the brush face and reaches a very high density at the trailing edge. In the case of over-commutation, high density is encountered at the leading edge of the brush, and a reversal of current at the trailing edge.

It may be seen from a comparison of curves in Figs. 19 and 20 that a badly distorted curve of short-circuit current may be, as it frequently is, the cause of extreme current densities at certain points on the brush face.

A good idea of the character of the commutation curve on a particular machine may be obtained by measuring the voltage drop between brush and revolving commutator at several points

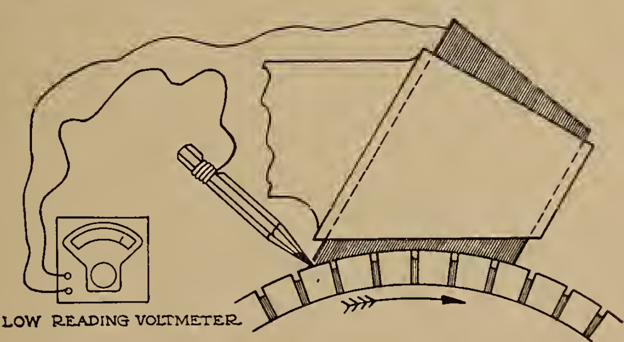
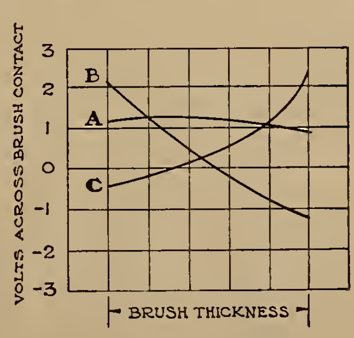


FIGURE 21
Measurement of contact drop at brush face

across the brush face. Fig. 21 illustrates a method for making such measurements and typical curves obtained in this manner. The lead of a hard pencil makes an excellent terminal for this purpose. Linear commutation will, of course, show the same voltage drop across the entire face. Curve A, Fig. 21, indicates a close approach to linear commutation. Curve B, indicating by excessive drop a high current density at the toe of the brush and also indicating reversal of current at the heel, shows a condition of over-commutation. Under-commutation is shown by Curve C which indicates reversal of current at the toe of the brush and high density at the heel.



As stated at the beginning of this discussion, no effort has been made to go far into the theory of commutation, and all attempt at mathematical analysis has been studiously avoided. A study of these elementary principles should, nevertheless, assist toward an interpretation of some of the commutation difficulties encountered in the application of brushes on motors and generators.

Craft Opinion on Reverse Prints Sharply Divided; Exchanges Hit

THE suggestion that release prints be shipped from exchanges to theatres mounted "in reverse" finds opinion among the projectionist craft sharply divided. As was to be expected, projectionists in the larger theatres which have fewer changes of program and which usually receive new prints in ample time favor the idea; while those who man the smaller theatres which have three or even daily changes of program give forth an emphatic "No!"

While opinion is about equally divided among those who have acquainted I. P. with their views on this topic, it is significant that almost all correspondents, even those who favor the plan in principle, express the fear that the introduction of reverse prints on a national scale will result in decreased vigilance in exchange operations and make for print conditions even less tolerable than at present.

Some observers, in fact, charge flatly that the plan was "inspired" by the exchanges and "sold" to commentators on projection matters as a deliberate attempt to shift a large measure of the responsibility for print inspection from the exchange to the projectionist. Being cognizant of the genesis of the reverse print idea, I. P. is able to dispel any fears on this score.

Practically all correspondents are in substantial agreement on the following points: (1) that present exchange practice is far below par on both inspection and shipping procedure; (2) that prints reach a majority of theatres too close to showtime; (3) that very few projectionists report for duty at least a half hour before showtime; (4) that adoption of the reverse print idea would mean that in thousands of theatres the first reel at least of a given show would have to be run on exchange reels, and (5) that every theatre should have and use its own reels, exchange reels being considered highly unsuitable.

● Exchanges in Key Spot

It is obvious that the proposition on the whole boils down to a question of whether, if the reverse print plan is put into effect nationally, the exchanges can be depended upon not to shirk their responsibility. Projectionist experience in the past, particularly since the adoption of the double-reel standard, would seem to demand a negative answer to this question. Both on the latter and in connection with handling of the S. R. P. in all its essentials, projectionists generally feel that the exchanges have failed by a wide margin to adhere to approved practice.

After canvassing opinion from the field, I. P. is inclined to favor the reverse print plan in principle, but it can neither ignore nor condone the compelling reasons advanced by those projectionists who favor rejection of the plan. The answer to the problem, if it be a problem, lies in exchange procedure, the nature of which to date is certainly not up to a point of efficiency where projectionists would be justified in any optimistic hopes for observance in the

(*Continued on page* 28)

Push-Pull Recording and Reproduction: The What, Why and How

By ***FRANK T. JAMEY***

While there has been and is much talk about "push-pull" recording and reproduction of sound-film, nobody has taken the trouble to explain in simple terms what the process is, how it got its name and what are its superior features. This article is intended to serve this need.

PUSH-PULL recording derives its name from the push-pull audio amplifier vacuum tube stage circuit. In an audio amplifier using vacuum tubes and with a low external impedance, the alternating output current may be represented by the curve *j* in Fig. 1. It is in phase with the input voltage and is the only useful current for amplification purposes. The harmonic having double the frequency of the fundamental, and represented in the same diagram by the curve *m*, is also present. This is the undesirable term which causes distortion.

To eliminate this undesirable distortion, a single stage of amplification employing two vacuum tubes may be used, as shown in Fig. 4. Since the potentials on the grids of the two tubes are 180 degrees out of phase, the fundamental currents (*j* in Fig. 1 and *j'* in Fig. 2) in the two plate circuits will differ by 180 degrees.

The displacement between the point *a* in Fig. 1 and *a'* in Fig. 2 is 180 degrees. The harmonics (*m* in Fig. 1 and *m'* in Fig. 2) will, however, be in phase. Thus by referring to the current directions in Fig. 4, the fundamentals will be additive in effect, while the harmonics will neutralize each other.

This process is illustrated by adding the curves in Figs. 1 and 2 180 degrees out of phase with each other. This may be accomplished by moving the curves in Fig. 2 180 degrees to the left (point *a'* to the position now occupied by point *b'*). Then adding the curves in the two figures, the result is Fig. 3. Curves *j* and *j'* add into curve *s* of the same frequency. However, curves *m* and *m'* simply cancel out. Thus, the undesirable distortion is eliminated.

Meaning of 'Push-Pull'

From this it can be easily seen that push-pull means push (add) the fundamental frequency and pull (neutralize) the harmonics.

For many years the problem of reduction of ground noise in film recording has engaged the attention of engineers. The objective was to increase the range of volume that could be recorded and to suppress the extraneous background noise to a level below the threshold of hearing. Only in this way would it be possible to create the suitable illusion of reality.

Up to 1934 several methods had been developed for reducing ground noise to a limited extent. At that time a new method of recording sound on film was introduced for variable-width records that permitted the reduction of ground noise to an absolute minimum, without introducing distortion. Since that time, this same type of recording has been used for variable-density records with great success.

In the variable-width recording one of the principal causes of extraneous noise is the film grain in the exposed portion, and foreign particles or scratches in the clear portion. In some cases the random distribution of silver grains and groups of grains causes the transmission through the dense part of

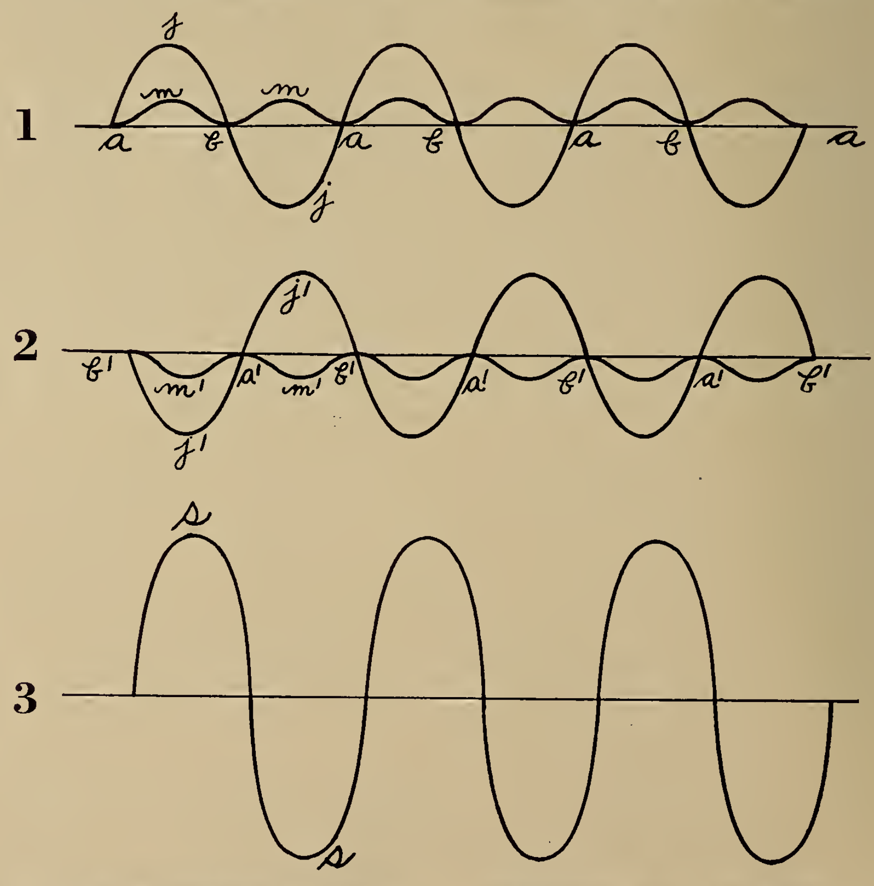


FIG. 1 shows fundamental frequency *(j)* and harmonic *(m)* with frequency of twice the fundamental for tube No. 1.

FIG. 2 shows fundamental frequency *(j')* and harmonic *(m')* with frequency of twice the fundamental for tube No. 2. These curves are 180° out of phase with those of tube No. 1.

FIG. 3 shows curve of the sum of Figs. 1 and 2 added 180° out of phase. This was arrived at by moving the curves in Fig. 2 180° to the left—that is, by moving *a'* to *b'*. Points *a* and *a'* and points *b* and *b'* then are one above the other. Under these conditions *j* and *j'* add up to equal curve *s*, but curves *m* and *m'* cancel out.

the sound track to vary and occasions a high-pitched hiss. Foreign particles and scratches on the transparent portion of the sound track form the most annoying cause of ground noise.

The photoelectric cell is unable to distinguish between the reduction of

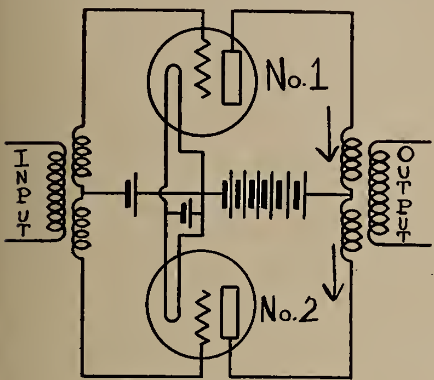


FIGURE 4

light due to a decrease of width of the transparent portion of the track and the reduction of light due to opaque particles in the clear track. Since the ground noise remains constant, the ratio of noise to signal increases as the signal is reduced.

Standard methods of recording on film, both variable-density and variable-width, have given a volume range of approximately 40 decibels at the expense of considerable distortion. This is accomplished through the use of a ground noise reduction system. In that system a portion of the signal is rectified, and is caused to operate either a shutter vane or a biasing winding on the recording galvanometer in such a way that the modulated portion of the track is reduced considerably.

For variable-width recordings, this system is inherently limited in the extent to which it can reduce film noise without introducing distortion. If it were to operate too quickly, an audible distortion would be superimposed upon the signal. If it were not to act quickly enough, the narrow track could not accommodate the beginnings of sounds that occurred suddenly, thus causing the first part of the sound to be distorted.

For variable-density recordings the principal limitation has been in the characteristics of the positive stock, plus the distortion due to the noise-reduction system because of its slow operating time.

● Cancels Out Distortion

The principle of the push-pull amplifier stage has been, therefore, applied to sound on film recording to reduce these limitations by cancelling these internal distortions. It became evident that if the sound track could be divided into two tracks, each of which had most of these internal distortions or where some were omitted, and then the tracks could be added together so that the distortions cancelled, a great useful volume range would be available.

The use of two such sound tracks would not materially affect the amplitude of the signal, since the two tracks are added together in the reproducing process to regain the advantages of a sound track of a width equal to that of a standard track.

At the present time there are two types of push-pull sound tracks in general use. Following the method adopted for the classification of amplifiers, it has been found convenient to assign the term "Class A" push-pull record to a record in which the wave is fully or integrally recorded in each track. In this case, each track may be a complete record. This method applies more particularly to variable-density recording.

"Class B" push-pull record is a record in which one-half of the wave is recorded, on the first track and the following half on the second track. This method applies more to variable-width recording. In both cases, the two tracks are recorded 180 degrees out of phase with each other.

In either case each sound track is reproduced separately through individual cathodes of a photelectric cell in the sound mechanism and then mixed electrically 180 degrees out of phase with each other. The process is just as described previously for the amplifier stage.

● Variable-Width Recording

In the variable-width method of recording, the use of the push-pull method permits the reduction of ground noise to a theoretical minimum. Only the area actually occupied by the sound record is transparent, which means that the ratio of the ground noise to the signal is constant, regardless of the amplitude. In this method the ground noise reduction system may be eliminated entirely.

In addition to its inherent freedom from ground noise, the push-pull sound track has other advantages of equal importance. The finite width and the spreading of the photographic image of the recording light beam are responsible for filling in the valleys and reducing the density of the peaks of the high-frequency waves. The push-pull track improves the condition in two ways. The negative is composed of peaks that are now separated from each other by clear spaces equal in width to a half wavelength. This is due to the other half of the wave being recorded on the other track. In order to make a good print it is necessary to make the peaks quite dense. In the standard system of recording a compromise between light peaks and dense valleys must determine the density of the negative. Elimination of the valleys from the negative makes it possible to increase the negative density and thereby obtain better prints.

Another important advantage of push-pull recording is the elimination of a kind of distortion that results from improper processing of variable width films. When high frequencies recorded on a sound negative are attenuated because of the finite width of the slit and the limited resolution of the film, a reduction of the average transmission also results. In this case a certain amount of distortion would accompany all high-frequency sounds. The distortion would be of the form of an extraneous noise produced by the envelope of the high frequencies, as shown in Fig. 5.

Some of this distortion may be eliminated by determining the negative and print density. The push-pull method completely eliminates all distortion that is not already printed out. As shown in the diagram, the positive and negative waves of the high frequencies are 180 degrees out of phase. and so are added in the push-pull transformer; but the envelopes of amplitude for the two tracks are in phase, thereby cancelling the distortion in the transformer.

● Variable-Density Recording

The exposure characteristics of the light valve used for variable-density recordings causes the introduction of considerable second harmonics in the higher frequencies. This is the result of the velocity with which the film moves. This harmonic is, of course, neutralized in the push-pull method. A second effect of

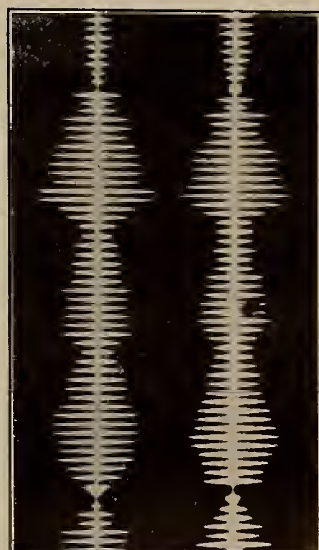


FIGURE 5

the film velocity is intermodulation between the high and low frequencies. When the modulation is sufficiently high that overload occurs, both even and odd harmonics are impressed upon the film

along with other products of the overload that are of such nature as to be largely eliminated by the push-pull arrangement.

The introduction of harmonics in the development and printing process are also cancelled out by the push-pull method.

One of the most important advantages of the push-pull recording system for variable-density records is in connection with the operation of the ground noise reduction system. Some low-frequency rectified components transmitted through the noise-reduction filter are introduced in addition to the signal recorded on the film. The effect is known as "shutter bump". The existence of this effect has restricted the application of noise-reduction principles.

In push-pull recording, while the signal is 180 degrees out of phase, the noise reduction modulation is in phase on the two tracks. Thus, these unwanted noise-reduction components, being recorded in phase, are cancelled out when the tracks are reproduced in push-pull. This makes possible a much faster operating noise-reduction mechanism which, in turn permits greater noise reduction.

In practical operation of push-pull systems in studios, the two qualities which appeal most to the recording engineer are the additional noise reduction made possible and the elimination of the harsh quality that has hitherto been characteristic of light-valve overload. The method also permits considerable reduction in the modulation of the light-valve for low input sounds, which in the past would have been masked by the background noise. This permits more natural recording of the volume range without raising the low signal or depressing the high signals.

Push-pull variable-density and variable-width recording are in wide use among the studios at this time for original recording. Since comparatively few theatres are as yet equipped to reproduce push-pull sound tracks, the number of pictures released with this type of track is very few. It is expected that within a short time enough theatres will be equipped to reproduce push-pull so that it will be practicable to release push-pull prints on a larger scale. However, a definite gain is now obtained in recording from this type of track to the standard single track, compared to re-recording from standard to standard track.

Data Anent Modern Negative Film Stock

The successful rendition of motion pictures is dependent in large part upon the quality of the negative film stock. Data anent the requisites for a good negative stock are set forth by Dr. Herbert Meyer, of C. King Charney, Inc., in the appended article, an excerpt from a bulletin published by the Technicians' Branch of the Academy of M. P. Arts & Sciences.

THE successful reproduction of natural objects on the motion picture screen by means of photography is utterly dependent upon certain qualifications of the light-sensitive negative emulsion used. The following characteristics can be named the most important ones in judging the usefulness of the negative medium considering the phase of photographing as well as reproducing a motion picture.

Maximum speed is essential and of advantage for many obvious reasons: Facilitating photographing under adverse light conditions, offering economical advantages when photographing interiors with artificial illuminants, and providing the possibility of improving focal depth by photographing with smaller lens openings.

● Color Balance

While it has not been possible so far to create emulsions sensitive to the visible range of light waves in such order or proportion as to duplicate the color sensitivity of the human eye, all modern panchromatic emulsions not only possess the ability to respond qualitatively to the entire range, but show also a rather standardized relation between the intensity of their color sensitivity towards the red end of the spectrum and the blue end.

Color balance as well as full panchromatic response are necessary in photography to obtain a sufficient effect of natural reproduction of color in black and white.

The fact that the finished motion picture is enlarged for projection on the screen to a size several hundred fold the original renders the grain problem most important. Consciousness of grain or grain effects when viewing motion pictures on the screen destroys the illusion of naturalness, as it makes the observer aware of the fact that the picture area is composed of different single elements.

The graininess (grain size) and granularity (grain distribution) of positive emulsions are always negligible. Both, however, are considerable quality factors in the developed negative and become most discriminating in the positive print as the individual negative grain or grain pattern is printed upon the positive material and is thus made visible in the projection of the enlarged positive print.

Gradation of an emulsion is analyzed by the so-called characteristic curve which is obtained by plotting different densities as a function of corresponding exposures. From this curve all important factors concerning gradation—such as contrast, gamma, latitude, and shadow speed—can be determined. These greatly influence the quality of the results obtained in the final projected print.

● Keeping Quality, Fog

The original characteristics of any photographic emulsion will change considerably in the course of time. Heat and high humidity accelerate this change. The manufacturer, however, is expected to produce emulsions with sufficient stability to be depended upon within a reasonable time. This necessitates rather complicated means of precaution during the mixing and ripening process while making the emulsion and, in addition, application of special chemical stabilizers.

Every emulsion has a typical initial fog characteristic which, however, also changes with age. It is desirable to keep the amount of this fog density as low as possible.

Considering the multitude of characteristics important to the professional

Local Autonomy Granted to I. A. Studio Locals

LOCAL autonomy has been granted to four West Coast I.A. local unions by the I. A. T. S. E. These locals, which have been under I. A. control since 1935, comprise cameramen's Local 659, lab. technicians' Local 583, sound technicians' Local 695, and studio technicians' Local 37. Only last year these same units voted to continue I. A. control.

Coincidently, it was announced by President George Browne that William Bioff has resigned as the former's personal representative and has severed all connections with the I. A.

Harold Smith, who has been active in directing the affairs of the West Coast Locals, issued a statement anent the decision to confer local autonomy which said in part:

"Autonomy was taken away from the four locals in 1935 following reorganization of the group after the disastrous studio strike during which the I.A. lost much of its work. The A.S.C., non-labor affiliate, obtained a 10-year contract with producers covering first cameramen's work and the I.B.E.W. obtained much of the electrical work formerly going to the I.A. With the signing of the basic agreement with producers prior to the suspension of autonomy of the studio locals, the I.A. gained closed-shop conditions and regained jurisdictional lines with the exception of cinematographers, who in the major studios still must belong to the A.S.C. However, all assistant cameramen and first cameramen on independent productions must be I.A. members.

"Also affected by the new order is Make-up Artists' Local 706, which joined the I.A. last year following the Federated Crafts strike. Although autonomous at that time, members and officers petitioned the I.A. for international supervision."

photographer, and virtually demanded of the manufacturer, it will be particularly evident how complex this problem becomes due to the fact that in manufacturing of emulsions the favoring of a single characteristic is in general limited by the observance that the maintenance of other characteristics as a direct result is impaired or even made impossible.

Thus, increase in speed might result in loss of gradation qualities, color balance, stability or in an increase in graininess. Improvement of the grain quality might necessitate sacrifice in speed and alteration in gradation, *etc.*

The latest panchromatic supersensitive negative emulsions offered by the different film manufacturers have been recognized as true masterpieces of combined research and manufacturing knowledge due to the advance they reflect over former types in individual characteristics, as well as in the balance of all qualifications desired.

Canada Sets Rules For Rapid 16 mm. Development

Quick to take cognizance of the proposed rapid development of the 16 mm. field in Canada, the Ontario government has established licensing regulations for 16 mm. theatres and halls. Established theatres showing 16 mm. pictures will be required to pay an annual $50 fee. A license levy of $10 will be imposed upon itinerant 16 mm. exhibitors, and the same charge will be made when 16 mm. is used in town halls or by organizations and clubs.

The new regulations also provide that Ontario 16 mm. houses must conform to the building specifications for 35 mm. theatres in the provincial code.

Meanwhile, Sovereign Films, recently organized to handle 16 mm. product in the Dominion, is preparing to establish branches in all film exchange centers. Asked as to what theatres would show the 16 mm. films, Sovereign, said a statement at this time was impossible—that the company was "sounding out the field." There is a report current, however, that Sovereign is considering renting town halls in various centers.

N. D. Theatre Divorce Law Goes to Supreme Court

Appeal to the U. S. Supreme Court from the decision of the three-judge court which sustained the North Dakota theatre divorcement act has been made. The act, enacted in 1937, prohibits operation of a theatre in N. D. by a distributor or a producer.

The court ordered restoration of the temporary injunction given March 11, 1938, restraining the state from enforcement of the act while the test case is pending. A cost bond of $1,000 was fixed by the court and an additional $1,000 fixed as bond on the reinstatement of the interlocutory injunction against the law.

BRENKERT-MOONEY NUPTIALS

Neal Brenkert, of the Brenkert Light Projection Co. and Rita Mooney, secretary to J. E. Robin, equipment dealer, were married recently. The bride formerly was active in the Independent Theatre Supply Dealers Assoc.

Notes on Mercury Vapor

In a recent paper[1] by the General Electric engineers relative to the new water-cooled quartz mercury arc appeared the following:

"The length of the source is not too great to be efficiently utilized in a motion picture projector. The width is insufficient to fill the lens system unless a cylindrical surface is incorporated. Several sources and images may be aligned side by side to provide adequate illumination for large screens. The color of the light seems satisfactory for black-and-white pictures. For color pictures, reds must be exaggerated in the film. If the pictures are also taken under capillary lamps, the intensification of the reds would therefore have to be compounded."

Discussion on this paper induced the appended question:

"I understand it is proposed to use several of these lamps together, as a projector light-source. The light would have to pass through the water jacket and several thicknesses of glass. Would you be able to obtain the effect of a solid light-source?"

The reply to which was:

"I believe so. The water absorbs infarad but not very much visible light; and since the water and glass are in contact there is little loss at that point."

[1] "Water-Cooled Quartz Mercury Arc," by E. B. Noel and R. E. Farnham, Journal of the Soc. Mot. Pict. Eng., XXXI (Sept. 1938), No. 3.

Answers to Queries Anent Color and the Human Eye

When I am afflicted with a spell of thought, I warm up on the question of why Technicolor prints require refocusing. The emulsion is in the same plane as black-and-white. The color correction of the lens would have no effect that I can see, particularly with subtractive processes. Or does it?

Is the sensitivity of the human eye linear? Considered as a whole, including the iris, I suppose not. But is the sensitivity curve the same for all colors? If not, the success of color projection would seem to depend on regulating the light on the screen within close limits, lest the balance be destroyed. This color mania may bring more headache than Sam Goldwyn can keep to himself. I. P. called the turn right before.

K. P. Kenworthy, Moscow, Idaho.

From Dr. Wilbur R. Rayton, of the Scientific Bureau of Bauch & Lomb Optical Co., comes the following reply:

"The color correction of the photographic lens used would certainly be of interest in Technicolor photography as much as in black-and-white. Whether an individual lens would require focusing, and how much, would depend on what two wave-lengths were chosen originally in correcting the lens.

"If your correspondent has had experience wherein refocusing was required, we would be glad to have all the details that you could get him to

disclose; namely, such information as the kind of lens, the focal length, the relative aperture, the amount of refocusing and its direction.

"In regard to the last topic, the sensitivity of the human eye to color is far from linear for the same amount of energy. It is most sensitive to green, and less sensitive towards the blue and towards the red. It is well known that in both directions the sensitivity of the eye reaches zero, that is, the eye cannot recognize as light wave-lengths shorter than something like 4000A, or longer than 7000A.

"These limits are not absolutely fixed and differ somewhat with different people. Your correspondent is therefore perfectly right in his assumption that careful recognition of the brightness of the projected picture would be required for the best possible color reproduction."

ST. LOUIS MOTIOGRAPH AGENT

Leroy R. Boomer has been named authorized Motiograph distributor in the St. Louis territory. Boomer formerly was associated with Joe Goldberg Co., Chicago, before which he was in the theatre and the film distribution and exhibition branches of the industry.

DUALS NO HEALTH PROBLEM

Milwaukee Oto-Ophthalmic Society, to which was referred the problem of determining whether duals are harmful to children's health, reports that they constitute not a medical problem but an economic one.

NEW CANTON, O., SCALE

Canton, Ohio, projectionist Local 671 is reported to have effected the following contract settlements: a slight increase the first year at the Palace and Loew's theatres, with a $2.50 weekly increase for two years thereafter. At Warner's a $3.75 weekly increase after the first year. Also, a $4 scale for midnight and other special shows.

'CAN'T HAPPEN TO ME'

Jack Page, projectionist, and John Lucas, manager, respectively, of the State Theatre, Idaho Springs, Colo., were seriously burned recently in an "explosion" in the projection room. Lucas had his clothes burned oft, while Page sustained severe burns on his hands and face.

NAME HABER SMPE CHAIRMAN

Julius Haber has been named chairman of the publicity committee of the S.M.P.E., succeeding Will Whitmore, who has resigned due to changes in the nature of his work with Western Electric. Mr. Haber, publicity chief for RCA Mfg. Co., will handle all general and technical S.M.P.E. publicity.

STEVENSON ERPI HEAD

T. Kennedy Stevenson has been elected president and a director of Electrical Research Products, Inc. (Erpi), succeeding the late Whitford Drake who died on Aug. 24. Mr. Stevenson has been associated with W. E. for 24 years, for the last 10 years of which he has been comptroller of manufacture. He is 55 years of age.

FREE ARC LAMP BOOKLET

Readers of I. P. may obtain free of charge an interesting booklet on projection lamps from the Strong Electric Co., 2501 Lagrange St., Toledo, Ohio.

NOTABLE LONG PRINT RUN

AS an instance of how it is possible by care and attention to keep film in first-class running order it may be mentioned that copy "C" of "Marie Walew-

ska," the M-G-M Garbo picture, which recently finished its run at the "Empire" and "Ritz" theatres in London had been through the projectors 420 times. Except for minute scratches at the extreme beginnings and ends of reels the print was in perfect shape and good for many more runs. The foregoing does not, of course, in any way constitute a record run of one copy, but seeing that copy "C" was handled by no less than twelve Guildsmen in both theatres, it would appear that this is just another instance of Guild efficiency and co-operation.—*British Guild Journal.*

PREDICTS GOOD FALL BIZ

Standard Statistics Co. predicts a good Fall season for the motion picture industry, due, it states, to the "prospect of larger theatre attendance and a relaxation of high amortization charges on expensive films of last Fall," which caused producers to cut costs to a point where quality suffered.

NEW ERPI 16 mm. RECORDER

Erpi has introduced a new 16 mm. recorder designed to enable the recording of 16 mm. negatives with the same facility and quality as is possible with 35 mm. stock. It has two immediate applications: direct recordings may be made independently, and by electrically interlocking the machine with a 35 mm. recorder both sizes of negative may be made simultaneously. It can also be used to re-record from existing 35 mm. product, thus permitting such changes in frequency characteristics as experience has shown to be desirable for reproduction on current 16 mm. projectors.

The re-recording can be made directly from a positive print or from a negative by use of the recently developed negative playback. This latter apparatus permits

the immediate reproduction of negative variable-density sound tracks and offers all of the oral advantages that would be given by a device capable of permitting one to view a photographic negative as a finished positive print, if such a device were available.

NBC resumed experimental television transmissions recently. Transmissions were discontinued early this summer to permit engineering and program improvements to be incorporated. Schedule will comprise six one-hour transmissions.

Managers, ushers and other members of a theatre's staff will not be affected by the provisions of the Federal wage-hours act, according to Elmer F. Andrews, administrator. These workers come under the jurisdiction of state laws, as a theatre, regardless of ownership, does not operate in interstate commerce.

H. M. Wilcox, 56, formerly vice-president of Erpi and subsequently a Paramount executive, died recently after a long illness.

Advertising Projection Equipment; Tinted Prints Like Tar Paper

HERE'S an ad lifted from one of our daily newspapers. It struck me as particularly significant inasmuch as we seldom see any such manifestation of good sense from the "front office," especially on projection matters. However, the craft goes on yelping merrily for more "juice" in the hope that some of the resultant light will pass through a .600 x .825 inch aperture.

With the fondest recollections of my magic-lantern days, I crave to come out in the open and say that this cockeyed business of ours is becoming as rattle-brained as a woodpeckers' convention. Hollywood, having learned just recently how to shoot stuff in focus, now permits the lab. technician to go loco on "tone moods," if you please, and no 125-ampere arc has a chance to penetrate current alleged prints.

Density the Big Problem

We go in for bigger and better projection equipment, get all "steamed up" over foot-lamberts (or any other good likker), and then Hollywood issues another super-epic on celluloid that resembles nothing so much as a roll of tar paper in the dead of night. What can I. P. do about controlled density of release prints?

P. E. THOMAS
Secretary, L. U. 593, Creston, Iowa.

S.M.P.E. Meets in Detroit Oct. 31 to Nov. 2

Detroit, Mich., will be the scene of the twenty-third Fall, 1938, Convention of the Society of Motion Picture Engineers, Oct. 31 to Nov. 2 at the Hotel Statler. Meeting in this city for the first time, the engineers will view at first-hand some of the great progress that has been made in industrial motion pictures.

A comprehensive program of interesting papers and technical presentations is being arranged. Karl Brenkert, of Detroit, is Chairman of the Local Arrangements Committee. John Strickler and A. J. Bradford, of Detroit, are assisting W. C. Kunzmann, Convention Vice-President, in arranging details of the Convention and the banquet to be held

on the evening of Nov. 1. Mrs. J. F. Strickler will act as hostess to the ladies.

Annual Awards Presentation

Notable features of the banquet will be the annual presentations of the Progress Medal and the Journal Award respectively. The Progress Medal is awarded annually by the Board of Governors of the Society, in recognition of any invention, research or development which, in their opinion, has resulted in a significant advance in motion picture technology. The Journal Award is similarly made by the Board of Governors to the author or authors of the most outstanding paper originally published in the Journal of the Society during the preceding calendar year.

Special hotel rates guaranteed to S.M.P.E. delegates and friends, European plan, will be as follows:

One person, room and bath	\$3.00 to \$6.00
Two persons, room and bath	5.00 to 8.00
Two persons (twin beds) room and bath	5.50 to 9.00
Three persons, room and bath	7.50 to 10.50
Parlor suite and bath, for one	8.50 to 11.00
Parlor suite and bath, for two	12.00 to 14.00

Room reservation cards will be mailed to the membership in the near future, and everyone who plans to attend the Convention should return his card to the Hotel promptly in order to be assured of satisfactory accommodations. Registrations will be made in the order in which the cards are received.

Opportunity will be afforded to delegates, after the close of the Convention, to visit some of the plants in and around Detroit. Hollywood has been selected as the site of the Spring, 1939, Convention, and New York for the 1939 Fall Convention.

CRAFT OPINION DIVIDED ON REVERSE PRINT PLAN

(*Continued from page* 19)

future of at least minimum approved standards of operation.

Representative opinions culled from among those received by I. P. anent the reverse print plan are appended hereto:

Our staff is flatly opposed to reverse prints, because when films reach our theatre in the evening for the next day's run, every foot of film is run through a measur-

ing device and inspected. Favoring reverse prints would be poor logic on our part.

LEO CIMIKOSKI, Norwich, Conn.

I favor reverse prints and have had the idea in mind for quite a while. It requires anywhere from an hour to an hour and a half to reverse the reels and then rewind them back on house reels, which means plenty of time and trouble. The exchanges make us send shows to them with the trailer out, so why can't they reciprocate? Thanks to I. P. and Mr. Richardson for this suggestion.

R. A. YOUNG, Homestead, Florida

Film should be shipped ready for showing on exchange reels. This permits inspection by hand rewinder and measuring for changeover cues and estimate of carbon stubs—with only two rewindings. With the film shipped from the exchange in reverse, it would be necessary to rewind three times to obtain the aforementioned results.

HARRY SMITH, Harrisburg Penna.

The "brilliant" idea of reverse prints doubtless originated with the exchanges, and Mr. Richardson evidently was selected to "sell" it to projectionists. Unquestionably film will be delivered uninspected, the projectionist being expected to do this chore for the exchanges.

As it is, the film comes to the second-class theatres uninspected, dirty, with loose bands and even with breaks—meaning that it was shipped just as it arrived from the previous showing. The excuse is, of course, that the print just arrived from out-of-town. It is clear that exchanges have insufficient help to inspect film properly. Should this scheme go through, there will be no need for film inspectors.

I wonder how Mr. Richardson would like to inspect from 10 to 12 reels of film every other day and go around with bandaged fingers? I hope projectionists will recognize this trick for what it is and boo it down with a bang.

S. ROBBINS, Chicago, Ill.

I certainly approve of reverse prints, because it would permit convenient inspection without the need for two rewindings. Some of the exchanges, especially Vitagraph, have terrible reels. Most all shorts from M-G-M are now coming through not rewound.

CHARLES SEIFERT, Easton, Penna.

Regaring the idea of reverse prints (not your idea, I am glad to say) here is one mere "operator" who says "No!" Granted that most of us inspect prints and mount them on house reels, the show often comes in late, and the audience gets restless waiting for a show that is anywhere from 5 to 15 minutes behind schedule. On such occasions, the harassed projectionist can only "run it out of the can" and hope for the best. It seems that the larger and more important is the booking, the later the show arrives, prints being scarce.

The idea sounds fine until one realizes that few of us work in a Broadway shift house. Also, in many small theatres projectionists are paid *only* for screen time, and prints shipped in not rewound would mean simply an added burden.

CLYDE RICHARDS, Corvallis, Ore.

It has been customary for exchanges in our district to ship reels ready for projection, which method we favor because we take the film off the exchange reels to our own reels in the enclosed rewinder. This gives us a tight rewind and enables us to measure length accurately.

Reverse prints would be fine, provided exchanges would rewind them tightly, or if each reel bore a correct footage marking.

ROBERT FERNER, Johnstown, Penna.

If there is to be a choice of rewind prints or not, we would prefer the rewound prints. This enables both the manager and projectionist to tell instantly just what film he has by removing the band and inspecting the title. If the film is not rewound, there sometimes exists doubt as to just what the film is, especially when older prints are used.

FRANK SUTTON, Norfolk, Va.

Reverse prints would be beneficial both to the theatre and the projectionist in general. The only objection I can see is that the exchange may be tempted to forego regular inspection, figuring to let the projectionist do their work for them.

P. F. PATERSON, Harrisburg, Penna.

The real low-down on amplifier circuits in the book SOUND PICTURE CIRCUITS. 208 pages of informative text; illustrations printed separate from text, insuring constant ready reference. Last edition now almost gone. Order direct from I. P. for $1.75, postage prepaid.

COMMON CAUSES OF BREAKDOWN IN SOUND SYSTEMS

(*Continued from page* 10)

circumstances makes replacement mandatory.

After filaments of the larger tubes, power transformers are the most important cause of amplifier overheating, and frequently cause more trouble of this kind than do tubes. The effects of excess temperature on other parts have been sufficiently discussed. If the transformer manufacturer indicates that his product is intended to "run hot" and will not suffer damage thereby, replacement still may be in order for the sake of general overall protection. Where this is undesirable, ventilation must be provided, either by removing the equipment to an airier location, by turning a fan on it, or both. The better apparatus is so designed that the power transformers, working at rated temperatures, will not overheat other amplifier parts even under adverse projection room conditions; but this is not the case with all equipment.

Resistor wear may give warning through momentary or partial interruptions, a warning that should never be ignored. The faulty resistor, when found, should be replaced immediately. Extreme heating on the part of any resistor, as compared with its normal operating temperature in the past, is also a danger signal calling for immediate action. So is any shrinkage in the insulating form, manifesting itself by a loosening of the resistance assembly.

Impending faults in soldered contacts and loosening of holding nuts, are best prevented by thorough, periodic inspection. Nuts that have once loosened should be checked monthly or more often, and tightened down as required. All soldered connections, including internal ones, should be checked about every six months, and any that arouse suspicion should be tightened up. Dirt is an ever-present hazard: volume controls and key switches should be cleaned weekly or monthly, and tube socket contacts every month or two, depending on the ventilation of the projection room, the type of floor and other factors.

Insulation should be inspected every six months at least (in overheated equipment, more often) for signs of charring or excessive drying out.

Speaker units and connections warrant thorough checking monthly, although when the units are completely enclosed in their baffles such inspection becomes less practicable. In every case, however, any trace of rattle in a speaker demands immediate attention, lest something tear loose.

Soundhead mechanical parts, as far as the operating side is concerned, are under constant inspection through the process of threading; but the drive gears should be opened to view about every three months and more often after they show serious signs of wear. New gears are ordered in good time to prevent prolonged delay in case the remaining life of those in use has been mis-judged.

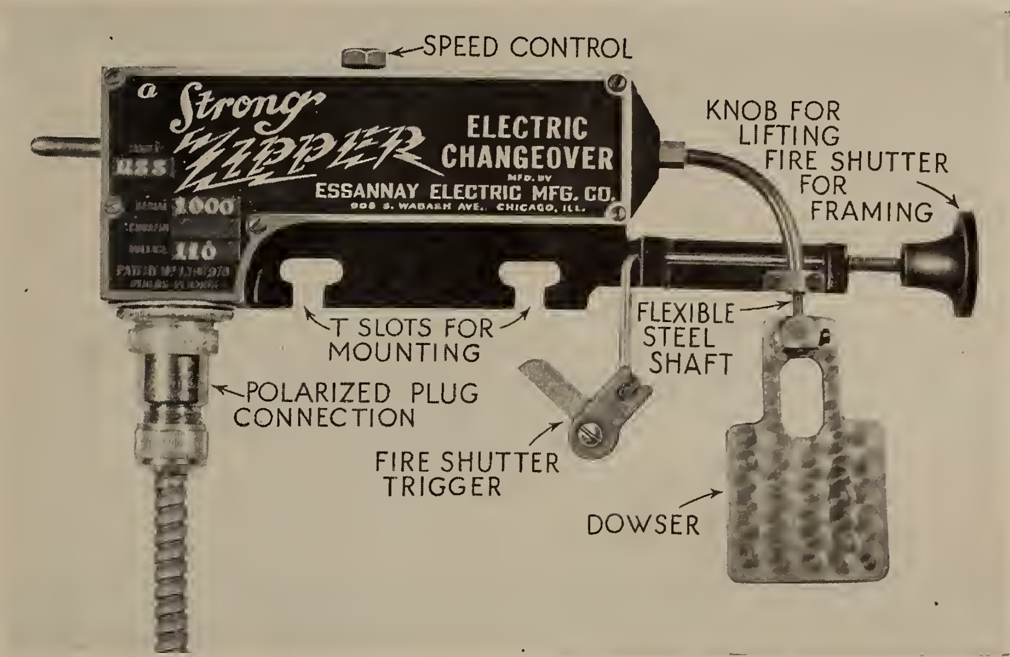
Safe operation of the equipment requires first of all such settings of the volume controls (where there are more than one) as will insure that no part of the system is overloaded through having to make up for unnecessarily great reduction in volume elsewhere. Operating voltages, which ultimately go back to the line voltage, are kept at normal value, a line voltage control device being installed where necessary for that purpose. Omitting such control is false economy, for even a rheostat, although not the most desirable contrivance for the purpose, can be used satisfactorily if finances allow nothing better.

Old tubes, partly worn controls, overheated resistors and condensers should be replaced without hesitation. Delay in such matters is again false economy, which may add the cost of extensive repairs to a replacement that, in any event, will have to be made sooner or later. The equipment is kept thoroughly clean, while periodic inspections look for such signs of impending trouble as have been described previously and for others peculiar to any given make or model of apparatus.

The Strong *ZIPPER* Changeover

Made by a Projectionist for Projectionists!

Offering Exclusive Patented Features Adaptable to All Makes of Projectors



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INTERNATIONAL PROJECTIONIST

OCTOBER 1938

VOLUME 13 • NUMBER 10

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International
PROJECTIONIST

With Which is Combined PROJECTION ENGINEERING

Edited by James J. Finn

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Monthly Chat

PROJECTIONISTS in general are not overly enthusiastic about reverse prints, judging from the number and tenor of the comments received from the field since the idea was first suggested. In some sections reverse prints have been commonplace for several years now and have been given ready acceptance by projectionists; but this fact impresses not at all those men in other sections of the country.

The main objection to the idea, as noted previously herein, is the fear that the general use of reverse prints will result in lax inspection work by exchanges, and no other feature of the plan apparently outweighs this consideration in the minds of projectionists. Overall an interesting proposal, but one that seems to be headed nowhere fast.

THE Projection Practice Committee of the S.M.P.E., now engaged in revision of standard projection room plans and consideration of the probable fire hazard connected with the handling of nitro-cellulose motion picture film, has enlisted the interest and aid of the National Fire Protective Association in its work. Once this job is completed, the powerful influence of the last-named organization will go far toward effecting substantial improvement in both projection room design and the safer handling of film in theatres.

When this happens the gentle cajoling incident to a campaign of education and persuasion must inevitably give way before a realistic policy of "Must!"—with no exceptions.

NEW and forceful emphasis has been placed upon the imminence of television on a commercial basis by the recent announcement by RCA that it is ready to go ahead on a more or less regular program basis. Just where motion pictures stand in relation to this art nobody seems to know definitely, but the topic has been productive of some intensely interesting theories. More on this elsewhere herein.

THE Suprex arc having failed to do more than merely dent the low-intensity lamp field, it is evident that research and development work must provide the answer as to how acceptable projection—particularly of color prints—is to be had in the smaller theatres. The latter assert that the cost of lamps plus conversion equipment is too steep a price to pay even for the fine light afforded by Suprex—which puts the answer squarely up to the equipment manufacturers.

NOTE how the Technicolor schedule is being upped: 25 features are set for the current season. Still a small percentage of the annual output of 600 films but gaining steadily. Black-and-white may be the exception rather than the rule within several years.

INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 10

OCTOBER 1938

Advance Preparations Minimize Sound System Emergencies

By *AARON NADELL*

IF SOUND breakdowns could always be foreseen in detail, few theatres would go dark for lack of replacement parts; but in practice temporary or "hay-wire" repairs are not infrequently needed to save a show during the time (hours or even days) a needed replacement item is in shipment. Such temporary measures are always more prompt, and nearly always more effective, when they have to some degree been planned in advance.

The most efficient form of advance planning is of course a well-stocked spare-parts box, but economic factors do not warrant maintaining a complete set of spares. No theatre does it, and many houses run their stock of substitute parts very much below the limit of safety. In both cases the projectionist can only plan to make up for such deficiencies by pre-arranging suitable emergency measures, and at the same time use such spare parts money as is allowed him efficiently by concentrating on items of equipment for which emergency substitutions are either impossible or difficult to arrange.

Other efficiencies in buying spares are also advisable, and will be touched on herein. One may be mentioned here: the stocking of a spare for any part used several times. Thus, if inspection of an amplifier diagram shows a number of condensers all of the same voltage and capacitance values, it is plainly advisable to have on hand one replacement, which can, obviously, be used for a number of different forms of trouble. The same reasoning naturally applies to resistors or any other component that is used more than once in a system.

But after the spares box has been stocked as thoroughly as practicable there still must remain many possibilities of trouble, remedies for which will depend either on the promptness with which supplies can be obtained or on the thoroughness with which substitute remedies have been prepared.

There is of course no substitute for the exciter lamp, the photoelectric cell, or for most of the mechanical parts of the sound head which are in any way likely to break down completely without warning. To some extent, emergency substitutions are possible in case of failure of certain tubes.

Rectifier Tubes

Rectifier tubes cannot well be replaced except by their duplicates or approximate duplicates, but the entire rectifier can always be dispensed with if other sources of power are available. The whole purpose of the rectifier is to provide direct current of suitable voltage, power and smoothness.

Low-voltage d. c. as used in sound systems can be supplied from a number of emergency sources, if suitable provisions are made in advance. The simplest substitution known to every projectionist, is that of storage batteries. Here

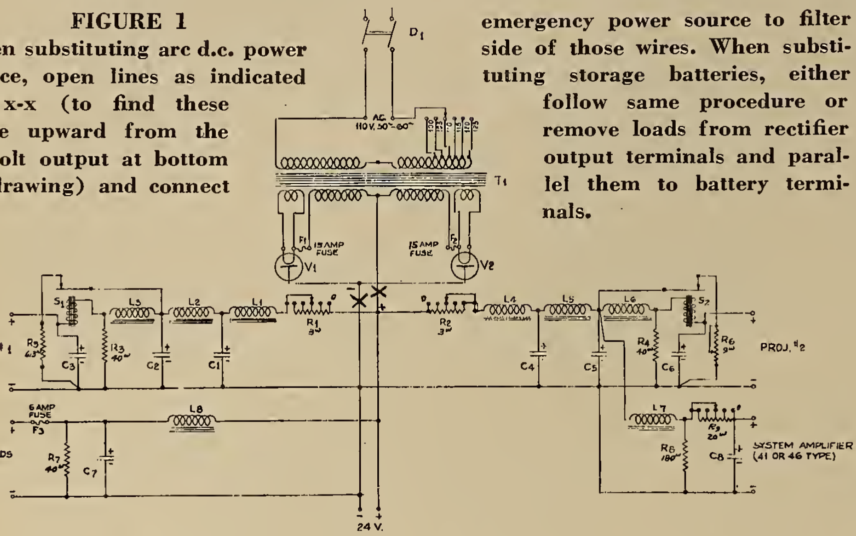


FIGURE 1
When substituting arc d.c. power source, open lines as indicated by x-x (to find these trace upward from the 24-volt output at bottom of drawing) and connect emergency power source to filter side of those wires. When substituting storage batteries, either follow same procedure or remove loads from rectifier output terminals and parallel them to battery terminals.

two steps in preparation are advisable. One relates to connections. It is highly desirable that the projectionist know in advance, without hesitation or fumbling, just where storage batteries should be connected to take the place of any defective rectifier circuit.

Some houses remote from aid go further: connection studs exist, wired in parallel and equipped with switches, to which batteries can be tied almost at a moment's notice. A second precaution, however, which is equally important and much more often neglected, is an advance arrangement with a garage or charging station to make certain that batteries can always be obtained. Cases are on record where unauthorized employees refused to rent batteries for any except automotive purposes, advising theatre people to "come back tomorrow and see the boss." A casual word to the boss in advance avoids such inconveniences.

A second source of low-voltage d. c. is the arc supply, which can very often be stepped down through suitable resistors, and filtered if necessary, to serve such purposes as lighting sound tube filaments or even exciting lamps, exciting speaker fields, or actuating relays. This source of d.c. cannot always be connected in the same circuit as storage batteries, for batteries deliver smooth current and need no filtering; while the arc supply, whether drawn from power line, motor-generator or rectifier, is likely to carry a ripple that needs smoothing out for some sound system purposes.

Thus when such substitutions are used in place of a defective rectifier, the battery is generally connected directly to the load, while the arc d. c. may often have to be wired into the rectifier ahead of the filter, to take advantage of the filter action (Fig. 1).

Where the arc d. c. source is used in this way, it should be noted that the drain of the sound system will very seldom be large enough to occasion any important change in arc voltage or current. The sound system, however, may be affected by the striking of the arc, and where a ballast resistor is used, sound connections are best made at the power side of that resistor, not at the arc side.

Sound rectifiers delivering high voltage present a more serious problem in the way of emergency substitution. Storage batteries are impracticable in that case—a hundred or more might be needed. "B" batteries of the type once used in theatres and still used by radio amateurs for various purposes, can be substituted temporarily—subject to two strong objections. First, they will run down quickly under the heavy drain of a sound system power amplifier, and they are of course moderately expensive. Second, only the larger radio stores now carry them. It still is not a bad idea to determine in advance whether any radio dealer within reasonable distance normally stocks enough of them to serve a theatre emergency.

It is particularly important, because of the rapidity with which B batteries run down when used to drive a large amplifier, that they be spared all unnecessary drain, and consequently be connected directly to the circuits they are to serve, skipping the filter (Fig. 2.). However, in some circuits, particularly in modern amplifiers, the resistors and condensers associated with the filter serve double duty in controlling quality or oscillation. This must always be considered before connections are made, and is a very important reason why amplifier diagram should be studied in advance and emergency connections planned when there is ample time to check possible mistakes.

In cast of the slightest doubt, it is obviously preferable to connect with the filter in the circuit, electing a greater drain on the batteries to distorted sound.

Better emergency sources than B batteries can sometimes be found. A large radio store, particularly one that does public address work, is very likely to have on hand an amplifier power pack that will supply thoroughly filtered current at high voltage, suited in every way to take the place of the normal supply of the average sound amplifier. Such current will not be impaired by double filtering, and may be connected where most convenient. This method is far cheaper and more dependable than B batteries, but its availability, the modifications needed, and methods of connection should naturally be worked out in advance.

One other point must also be checked in advance in every case, and checked carefully, regardless of the type of power substitute employed. That is the exact voltage needed at the point of connection, with the exact current needed for the circuits to be supplied, and the degree of filtering required in any case where there is a substitution of filters.

These questions are not difficult—they are very easy to handle if checked in advance. All that is necessary is to determine the points to which emergency connection will be made, and apply suitable voltmeter and ammeter readings (d. c., of course, in these cases). But easy as it is to obtain this data when the equipment is working normally, getting the same information after it has broken down may prove extremely difficult. Filtering is perhaps best checked by making the indicated emergency connection in advance of trouble, and listening for hum.

The considerations here suggested in the case of rectifier tube failure also apply in some degree, as will be seen, to power transformer failure and to trouble in the condensers and other components of the rectifier filter.

Amplifier Tubes

The amplifier tube is less susceptible to emergency treatment. Occasionally, however, substitutions are possible, particularly as between metal and glass tubes having identical characteristics. In such cases a satisfactory rush substitute may sometimes be found in a local radio store that does not carry a tube of the same type number. Somewhat more complicated, but still practicable in time of trouble, is substitution of a tube that has identical operating characteristics but different filament or heater requirements, which is very common. The 2A3 and 6A3 are examples of this relationship, the one using 2.5 filament volts at 2.5 amperes; the other 6.3 filament volts at 1 ampere. Another sub-

stitute for either is the 2A3H, 2.5 volts at 2.8 amperes. In such cases temporary use of a storage battery in place of the normal filament source may be required.

In most cases, however, when one amplifier tube cannot be found locally, its substitute is not likely to be available. Occasionally a stage of amplification can be "strapped out" and the volume control raised to compensate therefor. This is done in practice, but seldom through internal amplifier changes. The more common procedure is to strap out an entire amplifier. Some sound systems are supplied with factory-wired switching arrangements for this purpose. Many others, not so equipped, can readily be so modified in the projection room.

By far the best procedure in the case of amplifier tubes is to be sure at all times of carrying an ample supply of spares.

Condensers

When the condenser is part of a rectifier filter system, one simple emergency step is merely to disconnect it and run with such hum in the sound as may ensue. A second method would be to follow one or another of the suggestions already given with reference to rectifier tubes. Most of the power sources mentioned as substitutes are smoother than the normal sound rectifier output. This is true of line d. c. and motor-generator arc supply, and is also true of 3-phase arc rectifiers. Thus, substitution of such power sources may remove hum from a system in which the filter is temporarily short one condenser.

Emergency condensers can also be supplied through several expedients. One is to make up a large condenser of a number of small ones which may be found in the spare parts box, or, conversely, to make a small one out of several large ones. This can often be done by wiring in series or parallel. The effect of such wiring upon condensers is in a sense the opposite of the effect with resistors. When two condensers are placed in parallel, add their capacitance. When they are in series, however, the rule is the same as for resistors in parallel, namely:

$$C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4},\ etc.}$$

with reference to voltage rating, when condensers are in parallel every one of them must be capable of withstanding the full voltage of the circuit; when they are in series their resistance to breakdown adds, thus a 300-volt condenser in series with a 200-volt unit will withstand 500 volts.

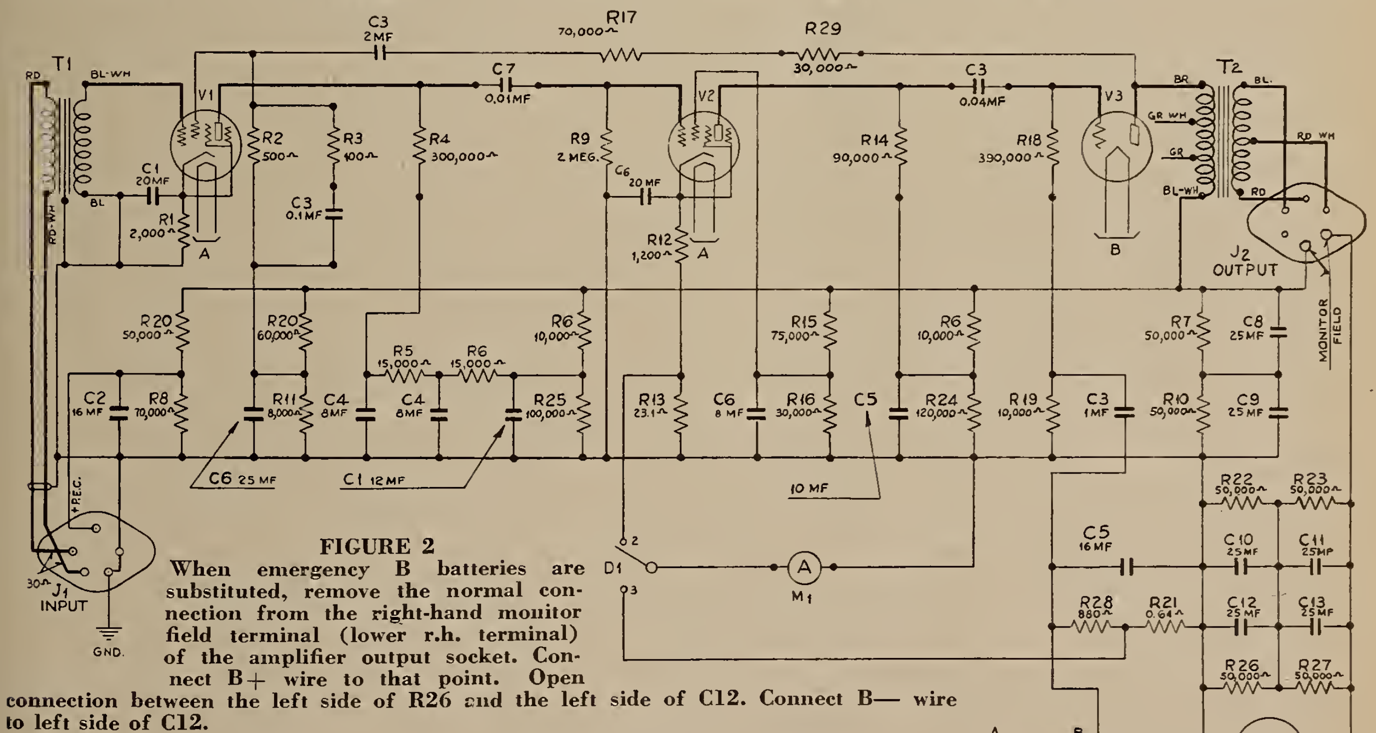
One substitution that can *not* be made is placing an electrolytic condenser in an a. c. circuit. It will break down. The paper or mica type must be used.

In some cases condensers can be improvised. Since the unit consists essentially of two conductors of large area, separated by insulation, there are many common materials that can be used. Once the writer, when remote from any source of supply, made a very satisfactory condenser of sheets of tin, spaced with squares of window glass. The capacity was about .005, while the voltage rating was far higher than 1,000. Metal foil and waxed paper can be used in the same way. All such expedients, however, are basically indefensible, because condensers are now far too inexpensive to justify even the most economical theatre in permitting its stock to run down. A mere handful, so chosen that they can in suitable combination substitute for any unit in the system, will cost less to keep on hand than would emergency materials for making fantastic substitutes. In a pinch, however, the substitutes are easily made, except for higher values of capacitance as sometimes used in the very latest amplifiers.

Power Transformers

It is occasionally practicable to remove a condenser from one part of the system, where its absence may do no more harm than increase the hum level somewhat, and use it elsewhere to remedy a total breakdown. For example, a 1-mfd. filter condenser may be substituted for an indispensable coupling or by-pass unit of the same value.

It is always possible to substitute batteries for a burned-out filament or heater transformer. Storage batteries are advisable, but sometimes it is also possible to use common 1½-volt, bell-ringing cells.



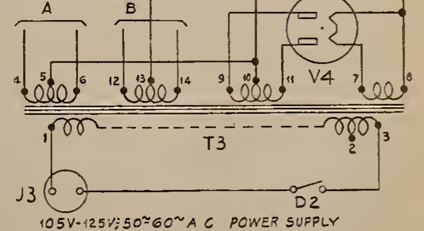


FIGURE 2
When emergency B batteries are substituted, remove the normal connection from the right-hand monitor field terminal (lower r.h. terminal) of the amplifier output socket. Connect B+ wire to that point. Open connection between the left side of R26 and the left side of C12. Connect B— wire to left side of C12.

One important precaution, however, is often overlooked.

In Fig. 2 transformer windings A and B are heater and filament windings, respectively. Both are center-tapped. The center-tap of winding A serves merely

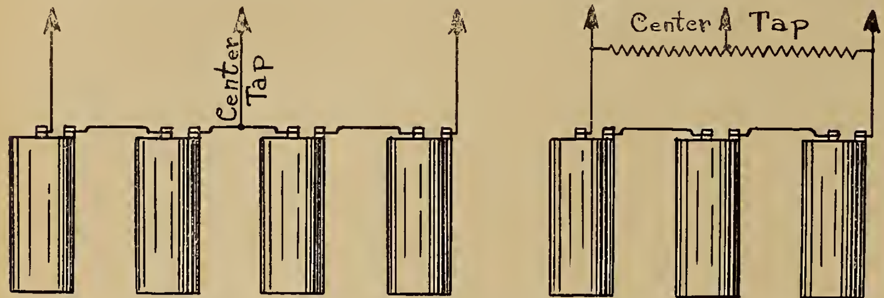


FIGURE 3

to reduce hum when the heaters of V-1 and V-2 are powered by a. c.; B center-tap carries the return for the grid bias of V-3. If that tap is connected to either pole of an emergency battery, the bias of V-3 grid will be altered. In this particular circuit the difference will be unimportant, a mere 2½ volts in a tube with a rated bias of —97; but in other circuits the difference might be very important.

If V-1 and V-2 were filament-type tubes, the corresponding shift in center-tap would make a 5-volt change in a rated grid bias of only —3, and conditions of that kind are not uncommon in practice, although less frequently encountered with the very latest equipment.

In all cases of filament transformer emergency substitution it is desirable to check center-tap connections and replace them, when necessary, by either of the methods shown in Fig. 3. The value of the resistor shown there is governed by the current it must carry, and as high as possible to avoid excessive battery drain; where it carries speech current, each half may be bridged by a condenser.

Plate transformer, or plate secondary winding, substitution, is more difficult of course because high voltage is required. One of the methods referred to in connection with high voltage rectifier tubes may be employed.

Failure of the primary winding of a combined plate and filament transformer, as in either Fig. 1 or Fig. 2, may require both filament and plate emergency substitutions. However, many such primaries are tapped for line voltage variation, as indicated in Fig. 1, and if the puncture should happen to occur between taps, it is in some cases possible to continue operation merely by connecting to one of the others.

In cases where the burned-out primary winding has grounded to the transformer core, it first may be necessary to insulate the core at that point. Similarly, where either the filament or plate winding of a combination power transformer has grounded to core, clearing the ground will be prerequisite before the other, undamaged winding can be used. If this proves impracticable, substitution for both windings will be necessary.

Speech transformers are less subject to emergency substitution, and the considerations mentioned in connection with amplifying tubes may apply. Fig. 4, however, shows one method of speech transformer emergency replacement. The transformer is disconnected entirely, and the parts indicated by the dotted lines are substituted. The left-hand resistor should have a value equal to the speech impedance of the transformer primary; where this is not known it can be approximated by reference to the rated load impedance of the left-hand tube, as given in any table of tube characteristics.

The standard rating, however, may not be accurate for the amplifier in question, since amplifier engineers do not always follow the recommendations of tube engineers. The right-hand resistor has a high value, from several meghoms to several hundred thousand ohms—higher for low-power tubes and Class A circuits; lower for high-power tubes and Class B circuits. The coupling condenser value need never exceed 1 megohm, and is usually a fraction of that capacitance.

If the substitution is planned in advance, with the help of inquiries directed to the amplifier manufacturer, exact values suited to any given case are readily obtained. Under pressure, almost any reasonable values will work more or less, provided only that care is taken to keep

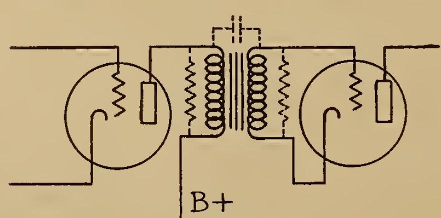


FIGURE 4

the left-hand resistor high enough in resistance to prevent excessive plate current. Modifications of the method can also be applied to the input and output speech transformers of an amplifier, but these seldom give away.

In the case of any coupling transformer which has in the past shown itself susceptible to breakdown as a result of carrying B current, the modification of Fig. 5 may be permanently installed as a safety measure, the manufacturer being consulted as to the rat-

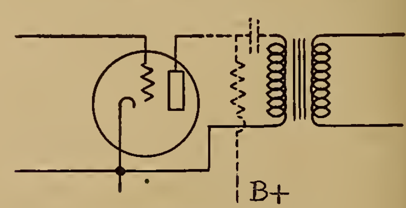


FIGURE 5.

ings of the parts shown by the dotted lines. Every manufacturer known to the writer, except one, will give such information.

Correction On Ontario, Can., 16 mm. Regulations

Correction of the report appearing in I. P. anent the regulations applicable to 16 mm. showings in the Province of Ontario, Canada, is set forth in the appended excerpts from a letter by Harry T. Dobson, Chief Inspector of Theatres:

"We were surprised to see on page 23 of I. P. for September an article covering the regulation by this province of 16 mm. shows . . . and at the mis-statements contained therein. The facts . . . follow:

"16 mm. . . . films can be shown in any licensed public hall in the Province . . . upon payment of a $10 yearly license fee . . . This license permits the holder thereof to show in as many locations as he desires. The $50 rental fee which was mentioned only applies as a license fee to film exchanges handling 16 mm. films, and not to standard theatres.

"At the present time the building standards which apply to 35 mm. theatres do not apply to any person operating 16 mm., inasmuch as no projection room, no fireproof construction of building and no licensed projectionist is required. The license fee for public halls in this province . . . follows: $3 for municipalities under 10,000 population, and $10 for other larger municipalities."

"SNOW WHITE" MONEY CHAMP

"Snow White" is headed for all-time, all-high championship box office honors with a probable potential world gross of $6,000,000, as against a cost of $1,670,000. First Warner talker, "The Singing Fool," is closest rival with gross of $5,250,000.

LOEW, PAR. EARNINGS

Indications are that Loew's Inc., will show a profit of $10,250,000 for the year ended Aug. 31 last, which figures to $6 a share on outstanding common. Figure is about 70% of previous year's earnings.

Financial circles estimate that Paramount will earn $800,000 for the quarter ending Oct. 1, with earnings for the year figured at $4,000,000.

Television and Its Effect Upon the Motion Picture Theatre

By *FRANK WALDROP* and *JOSEPH BORKIN*

TELEVISION eats up large areas of the spectrum to the starvation of other radio services, but that is not the end of its ravening. It threatens to swallow whole industries. Radio set manufacturers will have to transform their technique production so that they may become television set manufacturers. Radio broadcasters must become television broadcasters.

The radio set manufacturers, and the broadcasters who found the commercial band of the spectrum a vein of virgin gold, have recognized full well the danger that confronts them. In regiment formation they have bombarded the Federal Communications Commission to consider their interests as television approaches. They experiment, make treaties among themselves, and offer plans for protection. They might be called sprinters, crouched for the starting gun in a race that will end in fame and fortune for somebody.

But among the contestants we see an unwilling fat boy trying to assume the angular position of the ostrich with head in sand. That, in a word, is the way the motion picture industry is behaving as television comes.

The bulk of television programs will probably be in the form of motion picture films. For one thing films are more easily televised than stage performances, and have proved so successful that in the present experimental period sixty per cent of the broadcasts are from films. Apart from mechanical perfection there are other considerations. The film story technique lends itself naturally to television; and so does the scenic perfection that the motion picture industry has developed.

● **Movie Unpreparedness**

But television has a voracious appetite for material. If it comes to operate on a time schedule equal to that of present commercial radio, the present annual production schedule of films will not maintain service for more than three months. To keep up with such a pace the movies will have to undergo radical changes. Present production schedules, if quadrupled, still would not meet the demand. But even if the supply of entertainment can be kept up, the movies still may be reduced to a minor vestigial program service unless a sound bargaining position is established for them. Having undergone one radical change in ownership and financial structure because of unpreparedness, the movie moguls ought by now to be alert to technical change and its threats, but, alas, they seem not to be.

At present the motion picture industry is in two distinct though not entirely separate branches, each dependent upon the other. One branch is concerned with the production and distribution of pictures (Hollywood), the other with exhibition (America). Hollywood concerns itself with studio operation, photography, sound recording, the selection of artists and plots; in a word, with picture creation. Production could go on in a television era, only speeded up or slowed down to meet demand; and nobody outside Hollywood, except those holding stock in movie companies, would know or care.

The accompanying article is a reprint of one chapter ("The Somnolent Cinema") from the book* Television: A Struggle for Power, *published by William Morrow & Co., New York. 299 pages, illustrated, with index and bibliography, $2.75.

The exhibitors simply put the finished products before America today and try to ward off the headache which is surely going to overtake them with the advent of television. It would appear as though, when the new consumers are available at the studios, the producers may be in a measure freed from their dependence upon the exhibitor to whom they have had to cater for so many years; but actually the television broadcaster is merely substituted for the exhibitor.

The movie moguls have always been the victims of a mania for, and a complete failure to attain, independence. Before the advent of sound they used their fresh and copious profits to create exhibition outlets of their own wherever possible. Some of these remain today.

One of the first ventures into both sides of the market was made by William Fox, a furrier turned nickelodeon operator who acquired a producing company to guarantee his theatres films for exhibition. Fox is a rare character and one of those who make this story possible, for he not only bound production and exhibition together, but overlaid both with sound and with banknotes. At the advent of sound, Fox intensified the chain movement of theatres by pushing the industry into the new technique so that it had to be assured not only of actual distribution of product, but also of equipment in theatres to reproduce programs in a manner becoming the super-colossal empire that Hollywood conceived itself to be. On the practical side it was recognized that the movies could not go on half silent and half sound. Events and schemes pressed the moguls finally to choose sound.

The arrival of sound movies smashed the structure of such leading companies as Fox, Universal, Paramount, and Radio-Keith-Orpheum, and made them the vassals of bankers. Famous actors and actresses became as obsolete as wooden plows or handmade shoes. Theatre orchestras vanished into picket lines; and the legitimate theatre became an appendage. Today those few actors who refuse the western adventure find themselves cast in productions which are conceived, designed, and maintained in the sole hope that some film company will take an option on them.

Is it inconceivable that the next step in the theatre's metamorphosis is a vestigial movie house in which to test public reaction before the great exhibition to the nation by way of the radio spectrum? Will the motion picture theatres occupy the present situation of the legitimate theatre? To determine such questions as these the movie industry maintains an institution known as the Motion Picture Producers

and Distributors of America, headed by Will Hays, who was Postmaster General of the United States during the administration of Warren G. Harding.

● The Prall Report

In 1936 Mr. Hays hired A. Mortimer Prall to make a study of the relation of television to the motion picture industry. Upon learning that this research student was the son of the late Anning Prall (who was then chairman of the Federal Communications Commission, which also had the problem of television under study at that time),[1] one recognizes the astuteness of the "Czar of Hollywood."

Mr. A. Mortimer Prall, in a highly confidential document entitled "Television Survey and Report," advised the movie people that television opens a new and extremely important field for the industry. He pointed out that three times the amount of film they produced would be necessary for television. In addition, "the motion picture industry is composed of great production corporations. They possess every element necessary to the production of the finest programs of sight and sound on film. Writers, composers, artists, designers, architects, engineers, technicians, construction men, studios, special equipment and the world's best actors and actresses are all part of this industry . . . It is clear that the motion picture industry is the only source of supply for television programs."

Two plans were suggested in this report. One was that the present producers apply to the Federal Communications for permission to buy up one of the existing radio chains such as National Broadcasting Company, the Columbia Broadcasting System, or the Mutual Broadcasting System. The other was that the motion picture industry buy up stations not now in one of the four major networks and form a fifth radio chain. That too necessitates application to the commission for license. In other words, he suggested that the motion picture industry engage in the business of radio with the sanction of the commission of which his father was chairman.

There are several obvious faults in this plan. Sound radio is certainly a step towards television. But it must be recalled that television will play in the upper strata of the spectrum. There is, of course, no guarantee by Mr. A. Mortimer Prall that the commission will give the movie industry frequencies for television when the day for commercial exploitation arrives. It could happen that the movie industry would find itself left with two very large and moribund white elephants—the present motion picture studio and theatre system, and the sound radio system as well.

Is the exhibitor to be left to his fate by Mr. Prall? This is an important consideration, both for the producers and for the little men with neighborhood theatres. Because of their large investments in exhibition chains it would be suicidal to their capital structure for the great producing systems to allow their theatre investments to crash. But however we may pity them, we have to ask what incentives there will be for a customer to drive his car, run or even walk to a movie house when his own living room may become a theatre; and we can think of none that seems valid.

Maybe there are reasons why the movie palace will last despite television. One argument has been advanced to the effect that the theatre will remain as a place of assembly because man is naturally gregarious, but that possibility seems a poor comfort to the magnate whose fortune has to depend on it. Rather, he turns to a report of the Academy of Motion Picture Arts and Sciences which differs with Mr. Prall absolutely. It states that all is well and that the motion picture industry has nothing yet to worry about from television.

● Restrictive Clauses in Sound Film Recording Contracts

"There appears no danger that television will burst unexpected on an unprepared motion picture industry,"[2] says the Academy; and since that is comfort from his own, the magnate dreams comfortably of apfelstrudel and dividends. Whether this is simply whistling in the dark, or is a private word of assurance based on evidence undisclosed to the public, is anybody's guess; but at the risk of destroying peace of mind in Hollywood, we offer as a clue the following clause for a contract that conditions production by ninety per cent of the sound motion picture industry:

> No licenses are herein granted or agreed to be granted for any of the following uses or purposes:
>
> (1) For any uses in or in connection with a telephone, telegraph or radio system or in connection with any apparatus operating by radio-frequency* or carrier currents . . .[3]

Television can operate only on radio frequencies, or on carrier currents through wire cables. This clause is a part of the contracts between the American Telephone and Telegraph Company and seven of the eight major producers of pictures in Hollywood. Have the movie men been assured by their masters that television will be allowed to develop only as the masters will? Or have they overlooked that clause entirely and simply concluded that movies have their place in the world and can't be shaken out of it?

We cannot but succumb to our habit of quoting official documents as a means of showing that there is more than guesswork and intuition behind the warning that the movies may be on their way to extinction or absorption. Bear with us in a flashback of history concerning the sad story of the silent film and the sound machine. It is told briefly in two excerpts from the memoranda of a memorable character whom we shall identify shortly. He, more than any other, drove the nails in the coffin for Gene Fowler's fabulous "Father Goose." Here is memorandum number one:

> The motion picture industry in the United States owes us about sixteen million dollars and our expected revenues from the industry for the next ten years is about sixty-five million dollars. This is a large stake and establishes our interest in the welfare of the motion picture industry.
>
> The industry is in a serious financial condition and some of the large companies are faced with possible receiverships. The morale of the management in many instances has been greatly lowered. Unwise remedies are being applied and reorganization efforts are being made that in all probability will not be successful. As a result of these conditions our stake is in jeopardy.
>
> We are the second largest financial interest in the motion picture industry. Our stake is next to that of the Chase Bank . . .
>
> I believe that the protection of our interests in the motion picture industry requires that we should have authoritative conferences with the Chase Bank at the present time. Our interest should be made clear and our influence felt. We can do things the Chase cannot do in the interest of the common good and Chase can do things we cannot do . . .[4]

Number One was written on November 5, 1932.

Number Two:

> I have also had innumerable pro-

1. Broadcasting, June 15, 1937.

2. Academy of Motion Picture Arts and Sciences, Report on Television, 1936.

3. F.C.C., Special Telephone Investigation Docket No. 1 Exhibit No. 304. Contract between Electrical Research Products, Inc. and various motion picture producers.

*In the first sound recording contracts between the Bell Telephone system and the Vitaphone Corporation, television was specifically mentioned, but in characteristic fashion this was withdrawn as events and legal stipulations came near toward conflict.

4. Ibid. Exhibit 504. Letter from J. E. Otterson, President of Electrical Research Products, Inc., to E. S. Bloom, President of Western Electric Co., November 5, 1932. (Refer to 3.)

posals that ERPI go into this or that phase of the motion picture business. These I have declined without bringing to your attention because I recognize such proposals to be contrary to the Bell system policies and interests, and even though they offered ERPI opportunities for advantage and benefit. It is true today, as it has been for three or four years, that the Telephone Company can control the motion picture industry through ERPI without investing any more money than it now has invested.

I am not recommending that this be done, even though I know that the salvation of the picture industry lies in this direction. The industry is in crying need of the kind of strength and character that could be obtained through the influence of the Telephone Company.[5]

Number Two was written December 7, 1933.

Had "this direction," as described in the correspondence between J. E. Otterson and E. S. Bloom, officials of the American Telephone and Telegraph Company, been followed, all of the motion picture industry would soon have found itself under a single management, with a single studio operating organization and turning out pictures to be sold and exhibited through apparently competing sales systems. And, according to most standards of artistry and theatrical enterprise, disastrous effects upon the movies as entertainment would have been invited thereby.

It is crystal clear that only the judgment of its distant financial masters left the motion picture industry a figment of independence when it tottered under the impact of sound technique. That figment of independence has been nourished carefully since, but never enough to allow the original moguls to re-establish themselves completely.

Film Studios Barred

Let us remember and never forget that of the eight major producing companies, seven are bound up so that they cannot sell or lease their films for television if they want to; and that is why, perhaps, the Academy of Motion Picture Arts and Sciences recommends no fears. They put their faith in the cool judgment of the financiers far away to ward off the new threat. But what of the eighth major producer and what of that great industrial magic, Competition?

The telephone system moved in on the motion picture industry with a new technology, the sound films, and tied up ninety per cent of production with its contracts. Of the remaining ten per cent, the apparent competitive fringe, virtually all fell into the hands of the Radio Corporation of America, which proposes itself to be the perennial nemesis of the wired communications services.

And not too unsuccessfully, as witness this further memorandum by an A. T. & T. Company official:

> In the talking motion picture field they (RCA) are competing very actively with us at present, as you know, to develop an affiliation with the large motion picture producers, and competition between us all will doubtless ultimately result in a situation highly favorable to the motion picture interests and opposed to our own.
>
> This is an extensive and highly profitable field and it is quite worth our while to go a long way toward making it practically an exclusive field. I believe that we could justify from a commercial standpoint paying a large price for the liquidation of the Radio Corporation for this purpose alone.[6]

The author of this remarkable view was by no means foolish. Events show that he saw correctly the problems of protecting vested interests in times of technological change. And perhaps it is because the motion picture producers realize that they are really in no position of command just now that they cower like white rabbits as events start their march again.

5. Ibid. Exhibit 296, Letter Otterson to Bloom, December 7, 1933. (Refer to 3.)

6. Ibid. Exhibit 306, Letter Otterson to Bloom, April 29, 1937. (Refer to 3.)

A Higher-Efficiency Condensing System for Tungsten-Filament Projectors†

By *F. E. CARLSON*

ENGINEERING DEPARTMENT, GENERAL ELECTRIC COMPANY

SUMMARY: *In motion picture projection optical systems for tungsten-filament sources, the condenser design is such that the source is imaged well ahead of the picture aperture. This position is dictated by considerations of uniformity of screen brightness. It is not the optimal position from the standpoint of utilization of light, for it entails losses at the aperture. At the best position for efficiency, the degree of brightness uniformity is inacceptable because of the non-uniform brightness of the source. This paper describes a method for reducing such losses without sacrificing picture quality.*

THE design requirements of optical systems for picture projection have been well defined in technical papers over the years. It is well known, for example, that to achieve uniformity of lighting of the screen, condenser diameter and condenser-aperture spacing must be such that upon looking backward through the projection system from all points on the screen one will see equal areas of uniform brightness. In practice that is not completely realized at the margins because of vignetting by the projection lens tube.

Given a source of uniform brightness, uniform illumination of the screen is achieved with greatest efficiency in light utilization if the image of the source formed by the condensing lens lies slightly ahead of the aperture. When, as in Fig. 1 (*A*), the image is formed at the aperture, the light lost at this gate is at a minimum. However. the divergence of the beam is then so great that much of the light is not intercepted and transmitted by the projection lens.

As the source image is moved farther ahead, Fig. 1 (*B*), aperture losses increase, but a greater proportion of the remaining light is transmitted by the projection lens. It is apparent that for any given combination of condenser-aperture spacing, aperture size, and projection lens, there is an optimal position

†Journal of the Soc. Mot. Pict. Eng., XXXI, (August, 1938), No. 2.

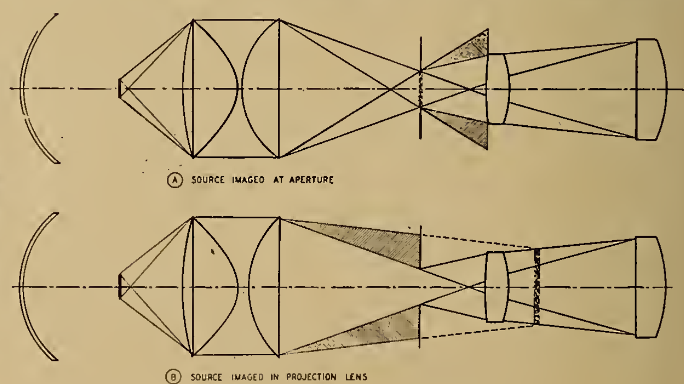


FIGURE 1
Effect of position of source image upon light losses at picture aperture and at projection lens

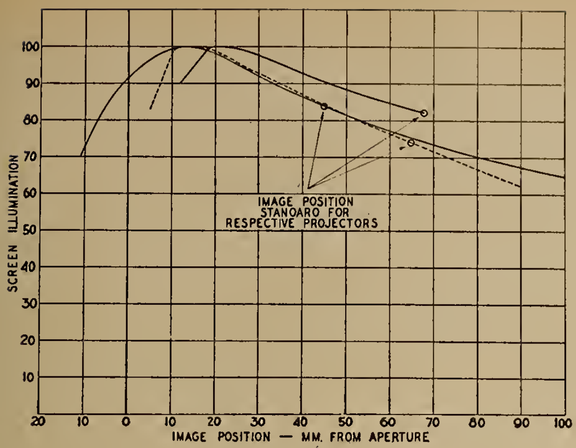


FIGURE 2

Relation of position of source image to screen illumination for 16-mm. projection systems with aspheric condensers

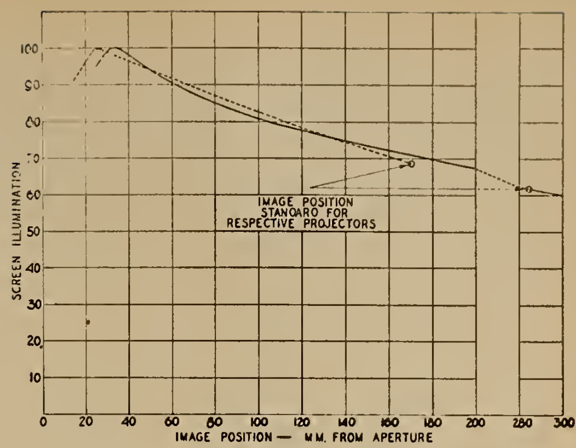


FIGURE 3

Relation of position of source image to level of screen illumination for 16-mm. projection systems with spheric condensers

where the sum of the two losses is at a minimum.

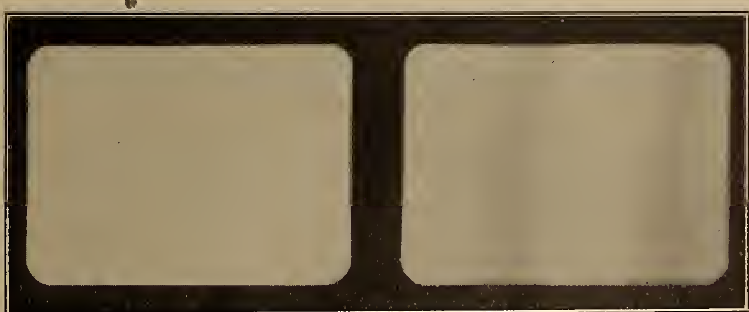
If the source be non-uniform in brightness, the image formed by the condensing lens will also be non-uniform. It is the degree of uniformity across the beam at the picture aperture that determines whether the screen is acceptably illuminated; and this uniformity increases as the position of the image is moved forward from the aperture. In practice the image has, accordingly, been placed a considerable distance from the point of optimal utilization of light. This paper deals with means for minimizing the losses that have heretofore been thus incurred.

● Effect of Image Position

In order to determine the effect of image position upon net output of projectors, tests were made with five typical optical systems of the 16-mm. size. The condensers employed included the usual spheric types as well as aspheric combinations. The light-source was an incandescent filament lamp of the conventional biplane construction, and of such size as to insure that the system was always completely filled.

Various image positions along the optical axis were attained by changing the focal length of the condensers. In the case of the spheric combinations, and in the aspheric systems combining all corrections in one lens, this was accomplished simply by substitution in the element nearest the aperture. In one system, in which both elements are aspheric, the focal length of the combination was changed by introducing a third element of appropriate focal length mounted close to the lens nearest the aperture.

The results of these tests are shown graphically in Figs. 2 and 3. While the data apply only to the five optical systems tested, they indicate the order of the penalty imposed by non-uniformity of source in projectors generally, whether of the 8-, 16-, or 35-mm. size. The standard position of the source image for each of the equipments tested is noted on the curves. It will be observed that in the aspheric systems the net output actually utilized is 16 to 25 per cent below the maximum possible, and that for spheric condensers it runs to nearly 40 per cent below.



(A) **FIGURE 4** *(B)*

Appearance of screen when source is imaged (A) at point of maximum light output, and (B) at standard positions indicated in Figs. 2 and 3

Figure 4 shows, in *A* and *B*, respectively, the approximate appearance of the screen when the image is focused at the point of maximum light output and at the positions actually used in practice. It will be seen that the lack of uniformity is evidenced crosswise of the screen, not vertically. In other words, so far as uniformity of brightness from top to bottom of the screen is concerned, the source could be imaged close to the position of maximum output.

● Condensing System Change

It has been standard practice to focus both dimensions of the source in the same plane. It is not necessary that that be done. A more rational procedure would be to incorporate a cylindrical or toric surface in the condensing system to provide a differential in the distance at which the vertical and horizontal dimensions of the source are focused. Such structures are commercially feasible. Cylindrical surfaces have, for example, been used to give the beam from a circular source an approximately elliptical cross-section in order to fit it more nearly to the dimensions of a particular aperture.

If, now the structure is instead adapted to focus one dimension of a rectangular source in the plane of maximum output, and the other dimension in the nearest plane for which uniform illumination results at the aperture, considerable gain in output can be achieved at the same time that uniformity of screen brightness is preserved.

Figure 5 illustrates three of a number of possible modifications of representative types of condensing systems to accomplish the differential focusing. *A* shows the simple case of substituting a cylindrical for a plane surface of a combination, thus producing a lens of shorter focal length in the meridian corresponding to the length of the coils of the lamp. In *B* the cylinder is concave instead of convex in order to increase the focal length of the meridian cor-

responding to the position at right angles to the coils of the lamp. If all the surfaces of the combination were spheric or aspheric one would provide, in place of the cylindrical surfaces illustrated, corresponding convex and concave toric surfaces. In *C*, two cylindrical (or toric) surfaces with their axes 90 degrees to each other are used to produce a differential in strength or focal length in these two meridians.

Lenses were made incorporating these principles, but otherwise identical with those employed in the above tests of conventional systems They were tested in three of the equipments, all representative of the high-quality group of 16-mm. projectors, with results as charted in Fig. 6. The increase in net output of the projectors varied from a minimum of 12 per cent for an aspheric, to 25 per cent for a spheric system. Factors affecting the realizable gain in efficiency include the angle of acceptance and the relative aperture and focal length of the projection lens, as well as the condenser-aperture spacing.

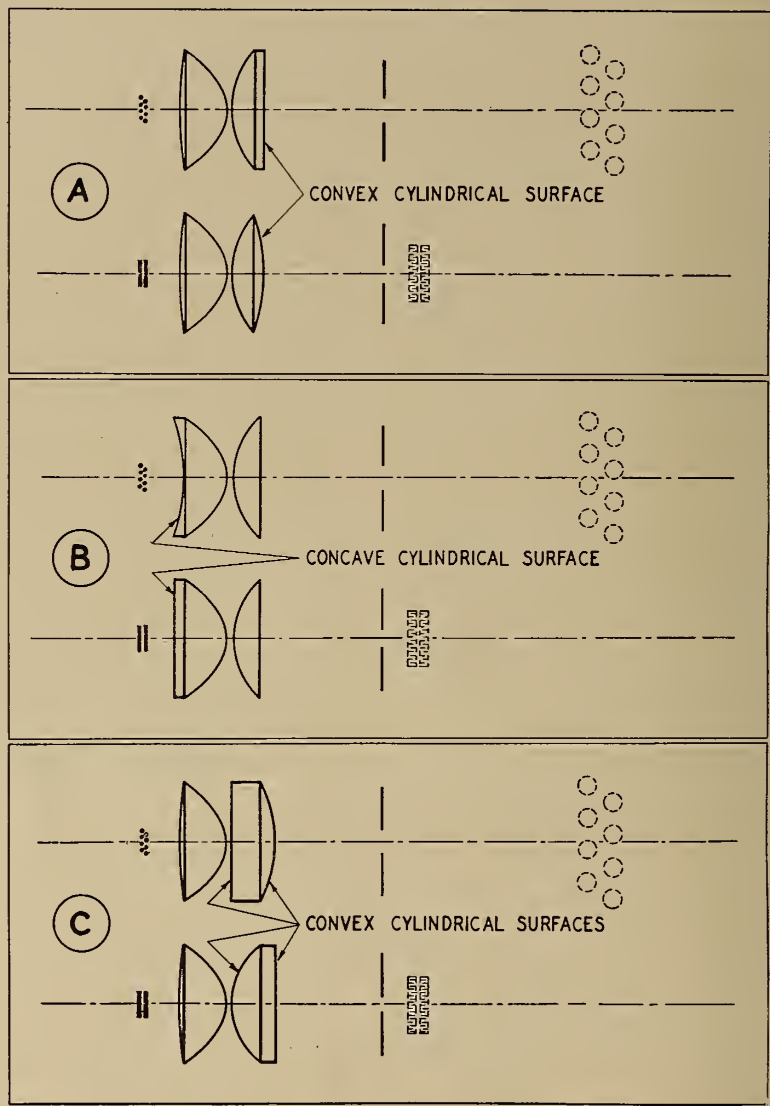


FIGURE 5

A few of the methods available for incorporating cylindrical or toric surfaces in typical condensing systems for differential focusing of width and height of source

DISCUSSION:

MR. KELLOGG: Your analysis and estimate of gain are based upon the supposition that you have a large enough projection lens to collect all the light that gets through the aperture; in other words, that you fill the lens with the filament image at all times?

MR. CARLSON: The gains shown are measurements and not estimated values, and there has been no change in any of the optical systems other than in the focal length of the condensing lens. That is, the projection lens was not changed nor was its position changed.

I doubt that projection lenses, even when used with condensing systems designed in accordance with present practice, collect and redirect to the screen all the light that gets through the aperture. Ignoring surface losses, there is usually some obstruction to marginal rays, varying in amount with the angle these rays bear to the optical axis. The reason we obtain a gain in screen illumination is that we are working at the point where the sum of the losses at the projection lens and at the aperture is reduced.

MR. KELLOGG: Would not your story be changed if you assumed a smaller projection lens? You are assuming, are you not, about as fast a projection lens as is practically available?

MR. CARLSON: Not necessarily. The data for each optical system tested were not included in the charts shown; but there were also tested in the course of the earlier experiments optical systems incorporating $f/2$ projection lenses instead of $f/1.65$, and the same relative gains seem to apply.

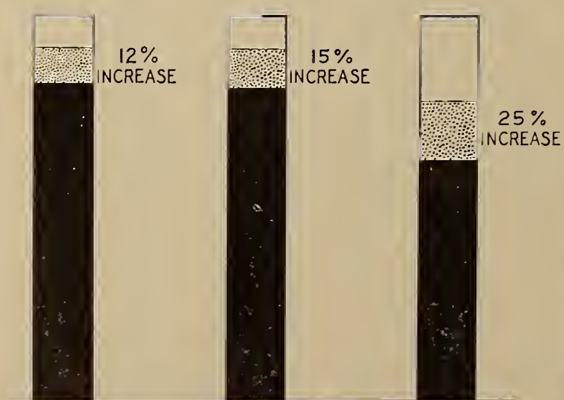


FIGURE 6

Increase in light output obtained by incorporating cylindrical or toric surface in condenser.

The height of the column represents, for each of three equipments, the net light output with source imaged at position for maximum light utilization, disregarding uniformity of screen. The black portion represents the part of the possible output realized in equipment as now made. The shaded blocks show the gain when condensers are modified as described.

The three columns are not to the same scale and therefore are not to be compared with each other as to absolute values

TIFFIN'S 25th BIRTHDAY

Tiffin, Ohio, Local Union 267 recently observed the 25th anniversary of its chartering by the I. A. Ed Tinney represented the I. A., while guest of honor was Joe Hixon, of Piqua, only living charter member of Ohio State Fed. of Labor. E. Banks, 267 president presided, and D. Henninger, secretary, reviewed the history of the Local.

Exhibitors were present and felicitated the Local.

Projection Possibilities of Mercury Vapor Discharge Lamp

By *R. HOWARD CRICKS*

TECHNICAL EDITOR, "THE IDEAL KINEMA," LONDON, ENGLAND

I WAS a little surprised to note in INTERNATIONAL PROJECTIONIST recently a statement by J. H. Kurlander[1] of the American Westinghouse lamp works to the effect that the vapor discharge lamp showed no early prospects of being adaptable for projection purposes. The reasons he gives are the ill-suited shape of the light source (which is 25 mm. long and only 1 to 2 mm. in diameter), and the need for water-cooling.

Mr. Kurlander's statement indicates that the glowing hopes expressed for the high-pressure discharge lamp when it was first demonstrated in this country some years ago are not likely to be realized in the near future . . . At the same time, one cannot help feeling that the intensive research work now being conducted in Europe and America must before long reach a favorable conclusion.

There are at least four laboratories in Europe actively engaged on this research: Philips of Holland (who, I think I am safe in saying, were the originators of the principle), G.E.C. at Wembley, B.T.-H. at Rugby, and Osram in Germany. I have no recent information of the progress made in America.

Each of the four European firms is making progress along a different line, and the summation of these four rising curves of progress—a summation which is eventually assured by the patents pool—may well lead to surprising results. First of all, let me summarize the progress of these four firms as far as it is within my knowledge.

● What is Being Done

Philips have recently marketed an exceedingly compact 500-watt high-pressure mercury-vapor lamp, with a very neat reflector system which forms part of the water-cooling jacket. I understand that a lamp of this type is being experimentally used for sub-standard projection, and, furthermore, that a lamp of similar type but of higher wattage, specially designed for projection, is shortly to be introduced.

G.E.C. have reached the stage of making up experimental studio lighting units. B.T.-H. have one or two developments up their sleeve in the direction of a three-phase air-cooled lamp—still, I may add, in the early experimental stages. Osram in Germany have actually demonstrated an air-cooled lamp claimed to be particularly suitable for projection, to which I shall refer more closely later.

A theoretical consideration of the principles of the discharge lamp indicates its two principal advantages—increased luminous efficiency and decreased heat radiation. This is because the light is produced not by raising a conductor —in this case the gas filling—to incandescence, but by causing its particles to vibrate at a rate equivalent to the frequency of light waves, their energy thus being radiated as light.

● Efficiency and Life

Unfortunately, this vibration partakes of the nature of resonance, and occurs at certain fixed frequencies, thus giving rise, at any rate at lower gas pressures, to only a series of bands in the spectrum, unlike a filament or carbon lamp, which has a continuous spectrum.

Some valuable information on mercury vapor lamps is contained in an article by W. R. Stevens, of G.E.C., in the current issues of the *B.K.S. Journal.* To summarize this article very briefly:

The high-pressure mercury-vapor lamp —the only type likely to be of interest for projection purposes—has a visual efficiency of 45 lumens per watt, with a rated life of 1,500 hours in the normal 400w. size; the actinic efficiency is still higher. Water-cooled lamps working at pressures up to 100 atmospheres have been made; the striking voltage is about 600v. for the 500w. lamp, and 2,000v. for the 2kw. lamp, the running voltages being about two-thirds of these figures. The lamps are, of course, fed through a step-up transformer from a.c. mains.

Anent the effect of gas pressure upon the color of the light emission: a 1-atmosphere lamp, emits light only in narrow bands of the spectrum; greater continuity is obtained at 10 atmospheres, while at 100 atmospheres the spectrum is continuous, with the exception of a gap in the green; the light has furthermore a much increased proportion of the red, which is deficient in the lower pressures.

A point of considerable importance is the lower heat content of the light. On a test plate, the temperature rise per 1,000 foot-candles with tungsten light is 11 deg. Cent., with an 80-amp. H. I. arc 6 deg. Cent., and with a water-cooled merury lamp only 1.5 deg. Cent. The gate temperature with a discharge lamp would thus be very much lower than with an arc for given light intensity.

● Water Cooling

The need for water cooling is an obvious defect in a lamp used for projection purposes, although I would not say that it is an insuperable bar to its use, particularly in view of the fact that on the Ernemann projector water cooling is already used in the gate.

This objection is, however, overcome in the recently demonstrated Osram lamp, which would, if reports are to be believed, be very adaptable to projection. In the 1,000w. size it has an almost spherical light source measuring 4.5 by 4 mm., and having a total emission of 50,000 lumens (50 lumens per watt). The 500w. model has a light source of 4.5 by 2 mm. In either case, the quartz bulb measures only 35 mm. in diameter, and, as I say, needs no water cooling. The working pressure is about 35 atmospheres.

This lamp would, too, seem to overcome the optical difficulties involved in

[1]August, 1938, p. 18.

Newburgh, N. Y., 2-Men Shift Law Passes Final Test

Appellate Division of N. Y. State Supreme Court has denied Orange County Theatres, Inc., petition to carry to Court Of Appeals, highest in State, unanimous decision upholding Newburgh, N. Y. 2-men projection shifts. This settles the case permanently.

Theatre circuit contended that the ordinance was unconstitutional, was enacted in bad faith (president of Local 45 is also Mayor), and that the city exceeded its charter powers. Ordinance provides, in addition to 2-men shift feature, for licensing board of five members: two projectionists, one master electrician, the city inspector and the fire chief.

imaging a line source of light upon a rectangular aperture. But again these optical difficulties are not insuperable. Philips have a patent for mounting such a lamp immediately behind the film, without the interposition of any condensers.

Their lamp, in which a tiny reflector actually forms part of the water-jacket, could be made to give a bar of light sufficiently high to cover the vertical dimension of the gate, and horizontally the light could be concentrated by means of a cylindrical lens. The whole thing could be very small, and might even be attached to the back of the gate.

One difficulty with these lamps is that when run on a. c. the light is practically extinguished at every alternation of the current, and at a mains frequency of 50 cycles and a picture frequency of 24, flicker would obviously be most objectionable. The solution put forward by B.T.-H. is to run the lamp from a half-wave rectified supply, and to run the film at 25 frames a second.

This method provides a further increased efficiency, since there is no loss of light due to the shutter; the increase in running speed would have the effect only of raising the pitch of the sound by rather more than a semitone—not a serious matter. It would, of course, be necessary to use a synchronous motor for driving the projector.

Another suggestion is to use a three-phase supply in a special type of lamp, but this so far has not proved practicable, and there would be obvious optical difficulties in concentrating light from a triple source.

● Safety Considerations

There remains one further objection to these lamps: the question of safety. I have already referred to the comparatively high voltages needed, particularly for striking; it is not to be expected that the authorities would permit the use of such high voltages in the projection room when regulations lay down a maximum a. c. voltage on the projector of 125v.

This difficulty, and also the difficulty just referred to of flicker, are apparently overcome by the Osram lamp, which can be run on 110v. or 220v. d. c. This necessitates a ballast resistance to reduce it to a lamp voltage of 85v., but there seems no reason why a constant-current rectifier circuit should not be employed.

Another potential source of danger is the risk of explosion due to the high working pressure. Although, due to the small bulk of the lamp, the explosion of such lamps is, as one experimenter put it, very disappointing, one firm is, I learn, perturbed at the risk—especially in studio arcs—of the red-hot electrodes being ejected with considerable force. This danger could, no doubt, be met by enclosing the lamp in a sufficiently sturdy housing.

● Summing Up

I have endeavored here to assess quite fairly the merits and demerits of the discharge lamp for projection. On the credit side it would have a considerably higher efficiency than the H.I. arc, particularly if, as suggested, it were extinguished during the shutter obturations; gate heat would be much reduced; both the lamp and its supply gear would be very much cheapened; the projectionist's skill or lack of it would have no adverse effect on the light, which would be absolutely steady.

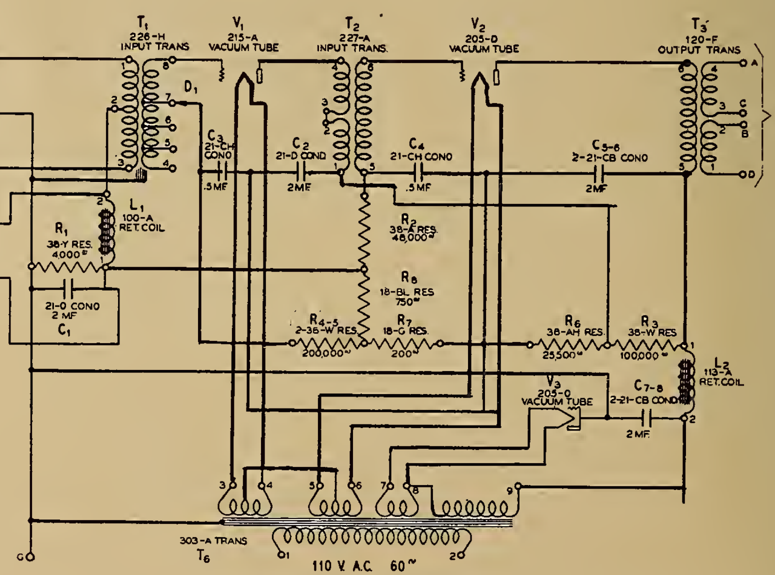
On the debit side there are at present to be considered the high working voltage; the difficulty of concentrating the light efficiently upon the aperture; the still not perfectly continuous spectrum, which would affect the projection of color films; the need for water cooling; and the necessity of replacing a possibly expensive lamp every three or six months, and furthermore, of replacing it before there was any risk of its failing in use.

Nevertheless, some of these difficulties are already being overcome, and in my mind there is little doubt but that in course of years the other defects will vanish. Already the discharge lamp is being used for sub-standard projection. Who knows when it may prove practicable for the cinema?

U. S. FILMS QUIT ITALY

Decree creating a film distribution monopoly for the Italian Government will effectively chase all American distributors and virtually end income from this market.

Complete This Drawing and Win a Year's Subscription to I. P.



AS A further practical aid in trouble-shooting and to familiarize projectionists with the procedure in tracing amplifier trouble by reference to a schematic diagram, I. P. presents here the first of a series of schematics which have been altered by the elimination of a vital component.

Each month a new diagram similarly altered will be presented, and projectionists are invited to send in to I. P. the corrected diagram. Applicable to this first schematic (any maybe thereafter, if there are not too many sharpshooters) to all contestants who submit a corrected drawing will be given a year's subscription to I. P.—we mean *free*.

The amplifier shown here has never been very widely used, thus affording an equal chance to all contestants. Assume that this amplifier is working in your projection room, and that suddenly there is no sound. Assume further that the cause is open-circuiting of some connection.

A wire or wires have been eliminated from this drawing, representing the open connection. Can you find where a vital connection is lacking in this diagram? If so, complete the diagram. Then send your answer to I. P.

The **IP** EDITORIAL PAGE

Vol. 13, No. 10 OCTOBER 1938

In Which Wrists Are Slapped

In these days of widespread discussion anent refinements in the art of motion picture reproduction—with special emphasis placed upon such topics as extended frequency range, the projection of color film, *etc.*—the tendency is to gloss over the fundamentals of the projection process and to take for granted those requisites which for years have been, and must continue to be, the "musts," so to speak, of the process. The one unforgivable lapse in projection technique (need we say it?) is a blank screen, irrespective of duration, the maintaining of a show on the screen being a hoary old craft tradition.

Employers welcome and appreciate anything that a projectionist can do to lend effectiveness to a screen presentation; but it is idle to think in terms of refinements in the art when there exists even a suspicion that the screen image will be interrupted.

All this is preliminary to consideration of occurrences in the projection field that, were not the evidence in support thereof at hand, would defy credence. Before us as we write these lines is a group of daily reports from projectionists of a moderate-sized circuit extending through several Eastern states. Let's have a look at some of the uninspiring comments anent operations appearing in these reports:

"Stop at 3:05 p.m. Mistake in threading film."—"Lost screen light at 10:51 p.m. due to the motor on arc feeding slow."—"Film break in trailers."—"Stop at 1:45 p.m. Film break."

"Stop at 4:58 p.m. Film break."—"Stop at 11:13 a.m. Broken carbon."—"Had blackout on changeover at 8:15 p.m. Should have threaded a short rundown but threaded a long one instead."—"Stop at 4:12 p.m. Top reel jerked and broke film." Same day: "Another stop. Spliced pulled away."—"Stop at 3:25 p.m. by lamp feed."

In one day at one theatre: "Misframe 12:28 p.m. on new show. Misframe at 3:59 p.m. due to loop jump. At 5:21 p.m. changeover shutter slipped down." "Missed changeover at 12:20 p.m. due to c.o. dot being in dark portion of film."—"Missed changeover at 12:28 p.m. because of missing first dot."—"Stop because of lamp dowser slipping on rod and failing to open full. In trying to raise dowser broke carbon."

Enough. Understandable is the failure to note changeover dots appearing in dark portions of prints; this is an old story—and a good one when explaining missed changes. But any projectionist worthy of the name could miss a c.o. dot only once and then only on the first showing. Film breaks are no novelty; ditto for defective equipment. But the other stated "reasons" for interruptions of shows are pure nonsense—and even at that we might include in this category both of the aforementioned "reasons."

All theatres in this particular circuit have ample manpower in the form of two-men shifts. In addition, there is a supervisor of projection for the circuit. In addition, the company has a definite policy of constant checking of theatre projection and prompt replacement of defective or worn-out equipment. Interruptions due to defective equipment is quite a mouthful to digest in view of the intelligent supervision and liberal replacement policy of this circuit. As for film breaks, it seems that this circuit utilizes ample manpower to make such an occurrence a rarity. And possibly these "projectionists" never heard of hand-feeding an arc in an emergency. It has been done.

I. P. is a projectionist publication devoted exclusively to the interests of the craft. Its function is to support not assail the craft. Its bellowings in behalf of the importance of the projection process to the success of motion picture exhibition, its advocacy of adequate projection supervision, and its many contributions to the cause of ample manpower, including much time devoted gratis by its representatives at various hearings on this issue—all this adds up to an impressive score. But there are times when soft words must be disdained in favor of a big stick. This is such a time.

Fumbling work of this sort puts the supervisor on the w. k. spot. "Cop" he may be termed, but he has no choice other than to read the riot act to those projectionists at fault—and if it comes to a pinch, he must request front-office backing for his stand. He can't possibly keep the front office in the dark about such happenings, even should he unwisely so elect, because the operating head can check the managerial reports which go direct to him. It so happens that the operating manager of this particular circuit is thoroughly sold on the value of good projection; he has demonstrated this on many occasions. He believes in ample manpower and a liberal equipment replacement policy. But what must be his emotions when he scans daily reports of a character outlined herein?

Only one course of action is open to the supervisor. Granted that the equipment on the circuit is in good shape, he can only send out a general notice to the effect that hereafter there must be no such lapses from accepted technique —or else! This statement might not sit well with some of our readers, but that's it.

Theatre projection is not an activity for amateurs; it's big-league stuff for professionals only. The only reason for operating theatres, the only thing that counts in the final analysis, is the probability that, through the application of proven correct operating methods, profits will accrue therefrom. Good projection is demonstrably a vitally important element in theatre operation. A blank screen is definitely a sign of sloppy projection work. These statements are commonplace in the art. Noteworthy is the fact that all the errors cited previously relate to *visual projection*, the tricks of which it is assumed were mastered years ago by the craft. This circumstance makes our efforts to unravel amplifier circuits look rather silly, doesn't it?

Moreover, the art and craft of projection has too few good friends among exhibitors to risk losing even one. The best asset the craft has are those exhibitors who respect both the art and the craft that can intelligently apply its supposed intimate knowledge of the profession to deliver the goods. We can yell long and loudly about how good we think we are and still not improve a single condition or add a thin dime to our income. But when we get a fellow on the other side of the fence to yell in tune with us, let's do everything possible to help keep him in key.

Get in there and pitch!

The Language of Lighting

THE use of the candle in the definition of light units is a natural outcome of the fact that measurements of light were first seriously undertaken at the time when the newer light sources began to replace the candle. A similar situation led to the introduction of the term horsepower when steam engines began to replace the horse. It was soon found that in order to use a candle as a standard, it had to be made according to strict specifications regarding size and ingredients and burned under prescribed conditions. The light in a horizontal direction would then have a certain intensity which could be taken as a standard.

A value for the standard of luminous intensity was established in 1909 by an agreement effected among the three National Standardizing Laboratories of France, Great Britain, and the United States, and is now maintained in these laboratories by means of incandescent lamps.

This unit may be used to specify the luminous intensity in candlepower of any light source in a given direction and represents the light density in that direction. However, the candlepower measured in one direction gives no indication of the total amount of light produced by the illuminant. Candlepower read in one direction is analogous to the depth of a pool of water at one given point—a measurement which is useful for certain purposes, but which is of no value in

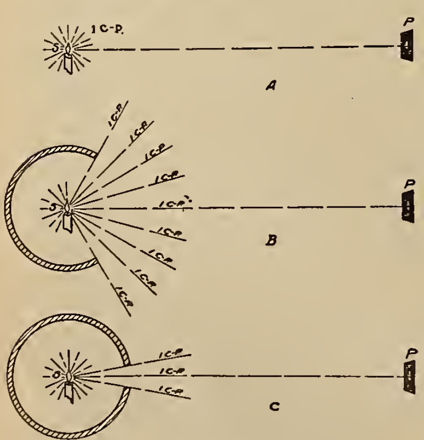


FIGURE 1

determining the total quantity of water in the pool. Just as it is necessary to know the dimensions of a pool and the depths at all points before its total

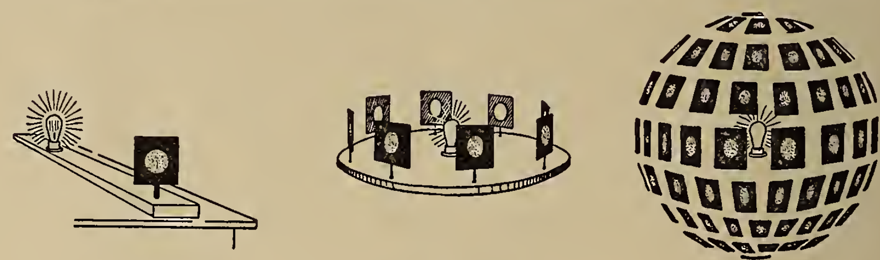
The intelligent application of light sources requires first of all a familiarity with the units used in the measurement of light and illumination. The four fundamental factors associated with the measurement of light are: luminous intensity or candlepower, luminous flux, illumination, and brightness. These factors are discussed and explained herein.

contents can be established, so it is necessary to know the candlepower of an illuminant in all directions before its total light output can be determined.

This fact that candlepower in one direction does not indicate total amount of light produced is illustrated in Fig. 1. In each instance the candlepower

measurements are ordinarily made are indicated in Fig. 2. In A, the candlepower of light radiating in only one direction is measured. When a number of readings are taken at uniform intervals in a horizontal plane, as indicated in B, and then averaged, the result is the mean horizontal candlepower of the light source. Instead of taking a large number of individual readings this result is obtained in ordinary practice by rotating the illuminant rapidly about its vertical axis while a single reading is taken. The intensity of light in all directions can be ascertained as indicated in C, by measuring the candlepower at uniform intervals around the light source.

An average of these readings will give the mean spherical candlepower



A—Horizontal candlepower

B—Mean horizontal candlepower

C—Mean spherical candlepower

FIGURE 2. *Measurement of candlepower*

in the direction of P is measured by means of an instrument known as a photometer, which will be described later. The reading obtained from the bare candle as shown in A is one candlepower.

In B, the same candle is surrounded by a sphere having a moderately large opening. Assuming that none of the light rays are reflected from the inside walls of the sphere, the photometer still will indicate one candlepower despite the fact that a large portion of the total light from the candle has been absorbed.

In C, a sphere with a much smaller opening is illustrated and still more of the light is consumed by the sphere, but even in this case the light in the direction of the photometer is one candlepower. In fact, the reading will be one candlepower irrespective of the size of the opening and regardless of light allowed to be emitted, provided the direct rays from the candle to the photometer are not obstructed.

Three ways in which candlepower

of the illuminant. In the past, it was quite common to rate light sources in terms of this unit, since it is directly related to the total light output of the lamp. At the present time, however, a unit known as the lumen is much more commonly used for this purpose.

● The Lumen

Light is not a concrete object which may be weighed or touched, but a form of energy in motion. For this reason, an amount of light cannot be strictly measured in the usual manner of measuring quantities. But light (more correctly, light flux) coming from a source may be considered to do so at a constant rate of speed. Therefore, for all practical photometric measurements, the element of time may be neglected, and light considered as a definite quantity.

The unit of this light flux or light quantity is the lumen. It may be defined as the amount of light falling on a surface one square foot in area, every point of which is one foot from

a uniform source of one candlepower.

If the opening indicated by ABCD, Fig. 3, is one square foot of the surface area of a sphere of one foot radius, the light escaping will be one lumen; if the area of this opening is doubled, it will be two lumens. Since the total surface area of a sphere with one foot radius is 12.57 square feet, a uniform one-candlepower source of light emits a total of 12.57 lumens. Thus a light source of 100 mean spherical candlepower emits 12.57 lumens.

Since an area of one square foot on the surface of a sphere of one foot radius subtends a unit solid angle at the center of the sphere, the lumen may also be defined as the amount of light emitted throughout a unit solid angle by a source whose average candlepower is one throughout the solid angle. From this point of view candlepower may be considered as the number of lumens in a solid angle and is thus a measurement of the light density in a given direction.

Summarizing the foregoing definitions of candlepower and lumen, it will be

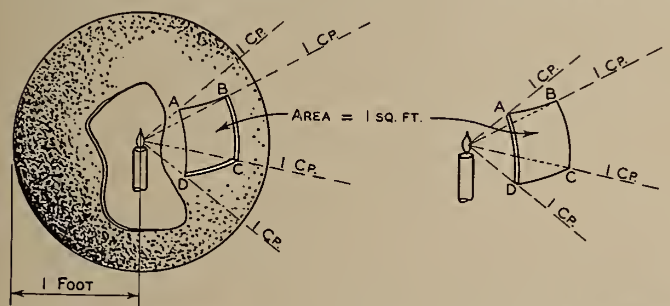


FIGURE 3

Relation of candles to lumens

seen that candlepower measures luminous intensity or light density of a light source in one direction only. It is no indication of quantity of light flux. The lumen, on the other hand, measures this quantity of light flux and does so irrespective of direction. When the various candlepowers in any solid angle are averaged (which may be considered as eliminating direction), there is then a definite relationship of the candlepower to the lumens in that particular solid angle. This is expressed by the statement that a source of unit spherical candlepower gives 12.57 lumens.

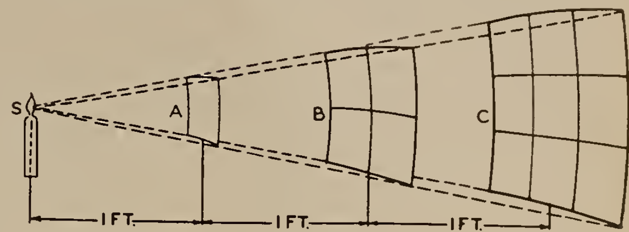
● The Foot-Candle

Light may be termed the cause, and illumination the effect or result. Since candlepower and lumens are both a measure of the cause, they therefore apply only to the light source itself and not to the effect or result obtained. For the measurement of illumination, a unit known as the "foot-candle" is used in the United States.

A foot-candle represents the illumination at a point on a surface which is one foot distant from and perpendicular to the rays of a one candlepower light source. If the light source S in Fig. 4 has an intensity of one candlepower

FIGURE 5

The inverse square law



along the line SA, and if A is one foot distant from the source, the illumination on the plane CD at the point A is one foot-candle. The illumination at the points C or D will be somewhat less than one foot-candle, since the distance from the source is a little more than one foot and the light strikes at a slight angle.

The illumination at A is one foot-candle only if the plane is perpendicular to the light ray which strikes the surface at that point. If the surface is tilted so that the light strikes at some angle other than 90°, there will be a corresponding decrease in illumination.

A foot-candle reading applies only to the particular point where the measurement is made. By averaging the foot-candle at a number of points, the average illumination of any given surface can be obtained.

The foot-candle is the unit of measurement most intimately associated with everyday use of light. A working idea of this unit may be obtained by holding a lighted candle one foot distant from a newspaper. The result will be approximately one foot-candle of illumination. The following table, which lists the foot-candle levels experienced in everyday life, will serve as a basis for a better understanding of the various levels of illumination.

	Foot-Candles
Moonlight	0.02
Well-lighted street (average)	1.0
Typical Interior	5-15
Daylight—	
At North Window	50-200
In Shade (outdoor)	100-1000
Direct Sunlight	5000-10000

Referring again to Fig. 3B, it will be seen that the surface ABCD fulfills the conditions for a surface illuminated to a level of one foot-candle. Every point of this square foot of surface is perpendicular to the rays of a 1 candlepower source which is one foot away. This brings out an important relationship between lumen and foot-candle. A lumen is the light flux spread over one foot of area which will illuminate that area to a level of one foot-candle, or 1 foot-candle = 1 lumen per square foot. This relation forms the basis of a simplified method of lighting design known as the "Flux of Light" or "Lumen" method.

When the number of square feet to be lighted is known and the desired level of illumination decided upon, it is a simple matter to determine the number of lumens which must be provided on the working plane. For example, to illuminate 100 square feet to an average level of five foot-candles, 500 lumens would have to be distributed uniformly over this area. This may be expressed in the form of an equation:

Area (sq. ft.) x Foot-candles (average) = Total Lumens

● Inverse Square Law

Another method of design known as the "point by point" method is based upon the well-known but widely misused inverse square law which also plays an important part in most photometric measurements. This law is illustrated in Fig. 5.

If the source of light is one candlepower, the illumination on a spherical surface one foot distant, as illustrated

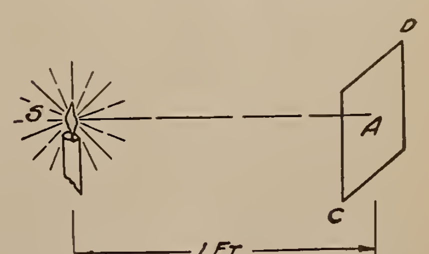


FIGURE 4

Illumination at A is 1 f.c.

by A, is one foot-candle. If surface A is removed, the same amount of light passes to surface B, two feet away, and here covers four times the

area of A. Since light travels in straight lines and none of it is lost, the average level of illumination on B, two feet away, is one-fourth as great as that on A, one foot away, or one-fourth of a foot-candle. If B is removed and the same amount of light falls on surface C, three feet away from the source, it will be spread over an area nine times as great as A. The resulting illumination is therefore one-ninth of a foot-candle. At a distance of five feet, the illumination would be only one-twenty-fifth of a foot-candle.

Illumination decreases not in proportion to distance, but in proportion to the square of distance. This fact is referred to as the inverse square law. It should be emphasized that this law is based upon a point source of light from which the light rays diverge as shown in Fig. 5. Practically it applies with close approximation where the diameter of the light source is not greater than about one-tenth the distance to the illuminated surface.

It is obvious that if in Fig. 5 the light source, which gives one candlepower in the direction of the surface A, were replaced by a source of two candlepower, the illumination at A will become two foot-candles. Likewise, the illumination on B, if A is removed, will be twice its former value; and similarly for C if B is removed. To sum up, it is possible to formulate the general law that the illumination, due to a point source, is equal to the candlepower of that source in the direction of the surface divided by the square of the distance in feet from the source to the surface.

Brightness

In defining illumination, it is not necessary to specify the character of the surface being illuminated, since, as should be emphasized at this point, the character of the surface has nothing to do with the illumination. This depends upon the total amount of light which it receives. Of this light, a part may be transmitted; the remainder is either reflected or absorbed. A surface which transmits or reflects light appears to be emitting light just as truly as a light source. It is by reason of light emitted, transmitted, or reflected that an object or surface appears bright.

There are two units of brightness in common use in this country at the present time: the foot-lambert and the candle per square inch. The foot-lambert is the brightness of a surface which emits one lumen per square foot. One advantage of this unit is that the brightness of a diffuse reflecting surface, so expressed, is simply the illumination in foot-candles multiplied by the percentage of light which is reflected by the surface. Its use also simplifies the computation of the number of lumens necessary, to produce a certain brightness in architectural elements.

The candle per square inch, equivalent to 452 foot-lamberts, is more commonly used to express the brightness of a light source or its enclosing globe. The brightness of the diffusing glass bowl of a study lamp, for example, must not exceed 3 candles per square inch if it is to meet the Illuminating Engineering Society specifications. Because of the fact that a bare lamp filament emits a large amount of light from a relatively small area, its brightness may be several thousand candles per square inch.

It is important that the difference between illumination and brightness be kept constantly in mind. If a piece of white paper which reflects 80% of the light incident upon it, and a piece of gray paper which reflects only 40% are placed side by side on a table top having a uniform illumination of, say, 5 foot-candles, both sheets will be illuminated to a level of 5 foot-candles, but the white paper will be twice as bright as the gray. It is this difference in brightness which accounts for the difference in appearance.

Difference in brightness, or contrast, is in fact the most important effect used by the eye to distinguish and identify objects. In reading ordinary print, for example, it is the difference in brightness between the black printed letters and the white background which makes it possible to identify the letters.

The following table lists the brightness of typical light sources in candlepower per square inch and should facilitate a better understanding of this unit of measure of brightness:

Source	*Cp. per sq. in.*
Gas Flame	2.5
Enclosing Globe	2.5-4.0
White Bowl Lamp	13
Frosted Lamp	50-60
Mazda C Lamp Filament	6,500
Crater of Carbon Arc	100,000
High Intensity Arc	400,000
The Sun	1,300,000

So far four units which should be thought of as forming the four corner stones of illuminating engineering have been defined. These are listed in the following table:

Quantity Measured	*Unit*
Luminous intensity	Candlepower
Luminous flux	Lumen
Illumination	Foot-candle
Brightness	Foot-lambert and candles per sq. in.

WESTCHESTER, N. Y., MOVIE BALL

Locals 366 and 650 of Westchester County, N. Y., will sponsor a giant Movie Ball at the White Plains, N. Y., County Center on Nov. 19. An elaborate program of entertainment has been arranged, in which will participate many stars of the screen, stage and radio. Affairs sponsored by these organizations in the past have been the standout social gatherings of the year in N. Y. State and an attendance approximating 5000 is anticipated in the huge County Center.

BROOKS CONGRESS NOMINEE

Harry M. Brooks, president of Troy, N. Y., projectionist local and former head of State Projectionist Assoc., is the nominee of both the Democratic and American Labor parties for Congress from the 29th district. Brooks, former State assemblyman, is opposed by H. Cluett, Republican, head of Arrow collar plant.

I. A. COAST PETITION

Petition by I. A. West Coast locals for certification by N.L.R.B. as sole bargaining agencies for studio workers, if granted, will in effect end the influence of the American Society of Cinematographers, which cur-

S. M. P. E. Exchange Group Opinion on Reversed Prints

Exchange Practice Committee of the S.M.P.E. has issued the following statement anent the proposed "reversed" reel as a nation-wide standard:

"Recently the question has been revived as to which is the better way of shipping films from the exchanges to the theatres—'heads-up' or 'tails-up'. About two years ago this Committee made an extensive study of the subject. At that time the Committee was primarily interested in determining the best method of splicing. Experts from Eastman Kodak and the Dupont Film showed by detailed drawings and specific data, that the most satisfactory patch was made when the film was being wound in the 'head-to-tail' direction, *i. e.*, leaving the tail out.

"A survey indicated that almost 88% of the film received back by the exchanges was wound with the tails out. This meant one of two things, *viz.*, either the majority of the theatres of the country were not equipped with special reels, or they could not spare the additional time required for rewinding in order to return the film 'heads-up'.

"Representatives of the various companies on the Committee felt that some expense might be involved if it were decided to adopt the 'tails-out' system, which involved additional rewinding. However, they were willing to go to this expense if the quality of the film delivered to the theatres and the resulting projection were to prove much better. However, in view of the overwhelming figures, which indicated that projection was definitely on a 'tails-out-return-to-branch' basis, the project was abandoned, and it has not been brought before the Committee again."

rently controls first cameramen. Latter classification not included in I. A. deal with studios under Basic Agreement.

Patent License War Rages; Government Intervenes

UNPRECEDENTED intervention of Dept. of Justice as a "friend of the court" to "protect the public interest" highlighted the re-hearing by the U. S. Supreme Court of the suit brought by A. T. & T. and affiliates against General Talking Picture Corp. on infringment of amplifier patents. Supreme Court previously ruled against GTPC in a split decision, but recently granted a rehearing.

Citing an early motion picture patent case, Sam Darby, GTPC counsel, pointed out that the Court in that case held invalid restrictions on patents after sale.

"By pooling of small patents, one concern is now in a position to hold a virtual monopoly" in the motion picture and other fields, Darby contended, terming the vacuum tube "absolutely essential" to the projection of motion pictures as well as to many other fields. Darby wants the Court to answer the following questions:

● Questions Posed to Court

1. "Can the owner of a patent, by means thereof, restrict the use made of a device manufactured under the patent, after the device has passed into the hands of a purchaser in ordinary channels of trade, and full consideration paid therefor?"

2. "Can a patent owner by means of the patent, merely by a 'license notice' attached to a device made under the patent and sold in the ordinary channels of trade by the patentee or by his licensee to make and sell, place an enforceable restriction upon the purchaser thereof as to the use to which the purchaser may put the device?"

The Dept. of Justice brief states in part: "Public policy can not tolerate the extension of the patent privilege to control the use to which the consumer may put the article after it has been marketed. No legitimate reason can be advanced as to why, to take a simplified example, the owner of a patent on a lighter should have the right to sell it to the public restricted to use in lighting cigars and not susceptible of legal use in lighting cigarets."

M. E. Clark, counsel for A. T. & T., styled the Dept. of Justice intervention as "most unusual" and declared: "Most of the Government's brief in this case is an attack on the telephone company because it is a party to the cross-licensing agreement. The Government is seeking to use this case to establish a new rule of law by saying that it is illegal for a patentee to license for one use and not for another." That, counsel continued, was "an astounding suggestion," and "those advancing it were not unfamiliar with what a patent is."

Public Television by RCA to Start in Spring

DAVID SARNOFF, president of RCA, announced recently the latest plans and policies of his organization in regard to the further development of television. He said that the results of the million-dollar field test conducted in the New York area since June 29, 1936, by the RCA in cooperation with the NBC, "have convinced us that television in the home is now technically feasible."

"We are aware, however, that many technical, artistic and financial problems still confront those who would establish an acceptable and regular public service of television programs to the home," said Mr. Sarnoff. "We believe that the problems confronting this difficult and complicated art can be solved only by operating experience gained from actually serving the public in their homes. Therefore, RCA purposes to begin a limited program service to the public from its New York television transmitter on the Empire State Building. This transmitter will serve an area having a radius of approximately fifty miles.

● Limited Set Quota

"We are planning to manufacture a limited quantity of television receivers, which we expect to market by the time the World's Fair opens."

To assist the RCA licensees who may desire to manufacture tele-receivers, Mr. Sarnoff said that such parts as they may wish will be available for purchase, and transmitting equipment will be available to broadcasters who may desire to enter the field.

Manufacturers pointed to New York, Philadelphia, Boston, Pittsburgh, Albany, Chicago and Los Angeles as sites where television is likely to get under way, because transmitters are already on the air or planned for these regions. All telecasts will be on ultra-short waves, which, under general atmospheric conditions, travel as a dependable service only as far as the horizon.

● Likely Price Range

Several manufacturers revealed that their engineers are already designing the instruments, which will offer pictures measuring 7 by 9 inches. Various models will be put on the market, with the styles ranging from a set that picks up only pictures to others that intercept both sight and associated sounds. A larger, but more costly machine, will be a combination designed for all-wave broadcast reception, television and phonograph.

While no prices have been placed on the instruments as yet, the manufacturers said the outfits probably would retail from $150 to $1,000. A machine retailing at about $250 is expected to be popular as a sound-sight receiver. Programs of an experimental nature will be on the air about two hours a week at first.

Diversity Features SMPE Convention Papers

SOUND recording on both film and disc, lighting problems of theatres and studios, 16-mm. recording and reproduction, and miscellaneous applications of cinematography lent variety to the subjects presented and discussed at the convention of the S.M.P.E. at the Hotel Statler, Detroit, Oct. 31 to Nov. 2, inclusive.

● Projection Committee Report

The question of fire prevention is receiving close attention of the engineers, with particular respect to the report of the Projection Practice Committee dealing with a proposed revision of the NFPA "Regulations for Handling Nitrocellulose Motion Picture Film."

S. K. Wolf, President of the Society, described a machine for producing reverberation artificially, a process that may prove of value to the studios in imparting a "live" quality to sounds recorded in more or less "dead" studios. F. G. Albin described a silent wind machine and J. E. Robbins a silent variable speed treadmill. G. L. Beers, E. W. Engstrom, and I. G. Maloff, of RCA, and I. J. Kaar of General Electric discussed motion picture problems of television.

Papers on various aspects of sound recording were presented by W. H. Offenhauser, of the Berndt-Maurer Co.; H. J. Hasbrouck, of RCA; F. Durst, of International Projector Corp., and R. O. Strock, of Eastern Service Studios.

Abstracts of many of the papers presented at the meeting are appended hereto:

CHARACTERISTICS OF FILM-REPRODUCING SYSTEMS

F. Durst and E. J. Shortt

International Projector Corp.

An analysis of sound-picture reproducing-system characteristics, including electrical and acoustical response data collected in the interest of determining the possibilities involved in obtaining an average characteristic for reproducing various film products with uniform response over several combinations of loudspeaker equipment. With the aid of a curve tracer having a long-persistent cathode-ray screen, a photographic record was made of the characteristics, starting with various forms and amounts of equalization and exploring their relationship to the power-handling capacity of amplifiers. Following through the system, this record shows the characteristics of dividing net-

works under various conditions of load, and finally the acoustical response curves taken for comparison of the loudspeaker equipments under study.

The measurements of loudspeaker combinations included various types of units, both permanent-magnet and energized, low-frequency horns ranging from open back baffles to folded horns with specially designed rear-loading compartment, and high-frequency multicellular horns of various configurations and constructional details.

After establishing the natural characteristics of the various equipments involved, careful listening tests were made over an extended period with samples of commercial prints and other recordings. A description follows of the difficulties and problems involved in an effort to obtain one overall characteristic, which would give satisfactory reproduction for all types of material. The final results are shown, with a short discussion of the methods for duplication in other equipment combinations, and concluded with recommendations for future designs and ratings.

SOME PRACTICAL ACCESSORIES FOR MOTION PICTURE RECORDING

R. O. Strock

Eastern Service Studios

The addition of practical operational accessories to standard recording channels as purchased expedites operation and saves time. At Eastern Service Studios a number of such accessories have been designed and will be described briefly.

Included in the equipment are the following items: A small collapsible, portable microphone boom for location work; a special microphone suspension to prevent mechanical noises from getting into the recording system; a small mixer console for stage work, to permit the mixerman to operate close to the scene of action; an accurate illumination meter, using a microammeter, for setting and checking the recording machine exposure; a compact re-recording mixer console equipped with equalizers, effect filters, amplifiers, and attenuators; a projected volume indicator and footage counter for use in re-recording rooms; a film playback adapter for use on a Western Electric film machine for location use; playback horns for stage and location use; and an airbrush adaptation for looping re-recording tracks.

LIGHTING OF THEATRE INTERIORS

F. M. Falge

General Electric Company

Here and there a theatre is planned with lighting features utilizing the fundamental principles that have been expounded on many occasions. In too many cases, however, interior lighting has lagged far behind exterior lighting for advertising, and owner and public alike have suffered. In too many cases, also, the theatre falls far short of complementing the attractive scenes so well projected upon the screen.

This paper reiterates the aims and advantages of proper lighting, and outlines the problem of locating, coloring, and controlling the lighting properly so that it will be comfortable and pleasing and an aid, psychologically. It discusses the possibilities of systems of lighting such as downlighting and fluorescent lighting. New materials and new light sources will be demonstrated and discussed.

New equipment for brightness measurement will also be shown as an aid in building up a quantitative background of what conditions conduce to comfort and satisfaction.

A SILENT WIND MACHINE FOR THE PRODUCTION STAGE

F. G. Albin

United Artists Studio Corp.

The machines generally used on the motion picture production set to create wind for pictorial effects are large motor-driven propeller fans mounted on floor stands. The noise level produced at high velocities is so high that satisfactory sound recording of the scene is practically impossible. Furthermore, the size and shape of these machines are such that they must be placed at such a distance that the directivity is not readily controllable. The additional hazard to sound recording of causing wind around the microphone always exists, and commonly, the desirable microphone placement is sacrificed in order to avoid the wind.

A new type of wind machine has been adopted and used for several years with a great improvement realized. The new

WEAVER 'JIFFY-JAW' SAVER FOR PEERLESS MAGNARC

The "Jiffy-Jaw" Carbon Saver for Peerless Magnarc lamps is being accorded an enthusiastic reception by projectionists using this type lamp. Built-on guides assure true alignment, and the Saver is warranted to last for at least a year. Made by Weaver Mfg. Co., 1639 East 102nd St., Los Angeles.

type is a centrifugal blower, such as is commonly used in ventilating systems. The air is conducted by means of light canvas ducts from the exhaust of the blower to the set where the scene is being enacted. The ducts are equipped with variously shaped fittings and nozzles so that the air stream may be directed as desired.

It has been found expedient to locate the blower outside the stage building and enter the duct through a special portal. Thereby, the greatest noise source, the blower, is remotely located and insulated from the scene by the walls of the stage building. Furthermore, it incidentally serves as a ventilator, supplying fresh air to the scene. Measurements of noise level for various wind velocities indicate improvements up to 70 decibels in noise reduction. Thus sound recordings of scenes requiring wind are made possible where heretofore it was necessary to photograph the scene without sound and provide synchronized sound subsequently.

THE EVOLUTION OF ARC BROADSIDE LIGHTING EQUIPMENT

P. Mole
Mole-Richardson Co.

From the earliest days of artificial lighting of motion picture sets the broadside type of unit has been a fundamental lighting tool. Regardless of the type of light-source used in such lamps—whether mercury-vapor tubes, carbon arcs, or incandescent filament globes—the broadside is a lamp of the floodlight type, designed to emit a relatively wide flood of soft, moderately powerful illumination. It has withstood innumerable sweeping changes in lighting and photographic technic, including the introduction and acceptance of spotlighting, the change from orthochromatic to panchromatic film materials, the changes from silent to talking pictures and from arc to incandescent light-sources, and the present growing popularity of natural-color photography.

The present paper will trace the evolution of arc broadsides only. It will comment upon the design and performance of the early-day units which were adapted almost intact from previous similar lamps used in photoengraving. It will follow the evolution of the broadside through successive improvements in silent-picture usages; through its decline at the introduction of sound and Mazda lighting; through the relatively recent rebirth of arc lighting due to the requirements of modern natural-color photography; and the most recently introduced units of this type which are replacing equipment designed less than five years ago at the introduction of the three-color Technicolor process.

Comparison will be made between the early, intermediate, and modern units as regards color distribution, light distribution, steadiness and length of burning period, indicating that though less public attention has been given to these types than to the more familiar spotlighting units, the broadside has kept pace with advances in lighting and equipment design.

CURRENT 16-mm. SOUND-FILM PRODUCTION METHODS AND APPARATUS

J. A. Maurer and W. H. Offenhauser, Jr.
The Berndt-Maurer Corp.

The development of 16-mm. sound-film is traced from its early activity shortly after 35-mm. sound-film was introduced commer-

cially, through to the present day. Some outstanding features of the early experimental projectors are described. Films used in testing the experimental projectors were essentially 16-mm. copies of 35-mm. commercial productions. The methods by which these films were produced are described and the influence of these methods upon present-day production explained.

Sixteen-mm. direct-recording development for a time followed essentially the same line of development as 35-mm. recording equipment. The present trend is explained and the differences in design detail pointed out. The importance of ruggedness and simplicity is stressed and the resulting effect upon equipment design with specific examples is outlined.

The processing procedures are explained and the influence of these procedures upon apparatus design are cited. A short demonstration of early films and present-day films will be made.

SOME PRODUCTION ASPECTS OF BINAURAL RECORDING FOR SOUND MOTION PICTURES

W. H. Offenhauser, Jr., and J. J. Israel

Binaural sound recording for motion pictures has a long development history of worthy achievement, yet to date it has not found application in our everyday entertainment sound motion picture. Inspection of the situation reveals that, like stereoscopic pictures, there is not complete acceptance of any of the various theories and that the shades of interpretation are so many that it is difficult to secure a consensus on what constitutes binaural sound recording for motion pictures. Instances are cited to show that "theoretically perfect" sound is not necessarily the objective; in fact, since it is the illusion produced, both by sound and picture that is in the final analysis important, "theoretically perfect" sound may even destroy the illusion we are trying to create.

The history of binaural sound recording for motion pictures is reviewed and especial reference is made to the early developments of Rosenberg and Kuechenmeister. A short review of the developments since the work of these pioneers covers in a general way the advance of the binaural sound motion picture recording art to date. The production requirements of binaural sound recording for motion pictures are analyzed briefly and the importance of the editing process in the production of the finished picture is outlined.

A new binaural sound motion picture pro-

duction technic is suggested, based upon the developments of the authors, that may be quite readily adapted to present-day monaural production technic. It is pointed out that the perspective sound control, which is an important added feature, does not affect shooting stage operations: this control is suggested as a logical part of dubbing-room operations. Some of the effects produced include variation of apparent recording-room size from very small, say, 1000 cu. ft. to very large, say, 500,000 cu. ft. Another important effect is the simultaneous yet essentially independent movement of one sound-source with respect to another and the essentially independent left-right movement.

All these effects are possible with no movement whatever of the sound-source or sources with respect to the microphones. Essentially the same effects can be obtained with the pseudo-binaural system, a system in which it is possible to take a completed picture of the conventional monaural type and by a simple dubbing operation, provide practically all the important binaural characteristics without any additional original sound recording whatever. The effects described will be demonstrated.

THE PROJECTIONIST AND THE FIRE HAZARD

Theodore P. Hover
Warner's Ohio Theatre, Lima, Ohio

Many groups have an interest in the prevention of fire in the projection room. Outstanding, of course, is the distributor, who must duplicate any film that may be destroyed, and, outside of replacement cost, is confronted with possible miss-outs and interrupted bookings.

The theatre owner is interested in possible damage of his building and equipment and, jointly with public officials, is interested in the safety of the audience. The projectionist, in the event of a fire, however, can lose his tools, clothes, and perhaps, his future health or his life, none of which have in the past been conceded sufficient importance. This paper deals with the projectionist's side of the safety problems in a projection room.

REPORT OF THE PROJECTION PRACTICE COMMITTEE

H. Rubin
Chairman

This report deals with two major projects completed by the Committee within the past six months, namely, the third revision of the Projection Room Plans and the proposed revision of the NFPA "Regulations for Handling Nitrocellulose Motion Picture Film." These two projects are given in detail. Other projects now under consideration by the Committee are briefly mentioned.

A MACHINE FOR ARTIFICIAL REVERBERATION

S. K. Wolf
Acoustic Consultants, Inc.

Sometimes there arises the necessity of introducing into recorded sound a liveness that is not present in the original sound-waves impinging upon the microphones in the recording studio. Reverberation chambers have been used to provide the additional liveness, but such chambers are not very flexible in use and are costly to install.

A new machine has been developed by means of which reverberation may be introduced into the recorded sound artificially. The sound is recorded upon an endless mag-

netic sound-carrier or tape, which passes beneath a number of pick-ups or reproducers at intervals along the carrier. These pick-ups are connected to a mixer panel, and the sound level of each is adjusted to produce the reverberant effect required. After passing the last pick-up head in the series, the sound is "wiped off" the magnetic carrier.

Such a machine finds many applications, and is useful not only in studios for direct recording, but also for adding liveness to records during the process of dubbing.

A 16-MM. STUDIO RECORDER

R. W. Benfer

Electrical Research Products, Inc.

Recent advances in the commercial use of 16-mm. sound-film have stressed the importance of improving the product. Certain limitations imposed by the optical reduction process for obtaining 16-mm. sound prints are eliminated by recording 16-mm. negatives expressly for contact printing. A studio recorder for this purpose is described. The paper deals briefly with the results of considerable investigation to determine the desirable recording characteristics and concludes with a demonstration of experimental recordings.

SILENT VARIABLE-SPEED TREADMILL

J. E. Robbins

Paramount Pictures, Inc.

Treadmills of various designs have been used by the motion picture industry for many years for obtaining animated shots in front of moving backgrounds. The adoption of sound practically eliminated them except for synchronized and other types of silent scenes.

This loss was keenly felt, and as a result immediate steps were taken to develop a unit that could operate throughout a wide range of speed, with fine control, instantaneous start and stop, and ability to reverse in the same shot, still maintaining a noise level that would allow the recording of intimate, quiet dialog. This was not as simple as it appeared, due to the fact that in addition to the above-mentioned requirements it also had to support the weight of two horses running, fifteen or twenty men on a march, automobiles and motorcycles in motion, *etc.* This all had to be accomplished with a unit restricted in size and weight in order to maintain mobility.

The paper discusses the problems confronting the engineering and mechanical departments throughout the design and construction of a machine that comes fairly close to doing all that was hoped for originally.

INDEPENDENT DRIVE FOR CAMERA IN THE A-C. INTERLOCK MOTOR SYSTEM

F. G. Albin

United Artists Studio Corp., Hollywood, Calif.

The "Selsyn" or alternating-current interlock motor system used to drive cameras, recording, re-recording, and projection machines in synchronism, is a popular type of motor system in large studios. It has special advantages in such applications as driving projector and camera for projection background process. The one inexpedient feature is that the system is generally started from a central point such as the recording room, and the cameraman does not have means for running his camera independently as is so often required for photographing slates, exposure tests, and silent scenes.

An addition has been made to the a-c. interlock system to give it the advantages possessed by the synchronous motor system: namely, the facilities enabling the cameraman to operate his camera at will at regular speed.

The addition consists of a set of relays with control circuits, and a frequency changer and field exciter set. Normally, the camera motors are connected to the common interlock system through the relays. If, however, the button provided at the camera is depressed, the pilot relay operates and energizes the main relays which transfer the camera motor circuit to the bus of the frequency changer and field exciter set. The camera motor is operated as a true syn-

chronous motor. One phase of the rotor is short-circuited, and the remainder is excited with direct current and serves the field. The three-phase stator is supplied with three-phase power of a frequency that will cause the motor to run at the required speed, the same speed as when driven with the interlock system.

The power developed by the a-c. interlock camera motor when operated as a synchronous motor is approximately the same as under normal operating conditions. The acceleration is typical of small synchronous motors when the power supply is suddenly connected. The pull-in torque is superior to the slotted-rotor type of as-synchronous motor. The operation of the system is smooth, simple, and efficient, and has, after several years of use, proved its value.

NEW SOUND RECORDING EQUIPMENT

D. R. Canady and V. A. Welman
Canaday Sound Appliance Co.

Recorder for 16-mm. Film.—This recorder is characterized by its constancy of speed and its convenience and simplicity of operation. The constant-speed drum is not affected by temperature changes. The recorder has an aluminum magazine of 400-ft. capacity, with friction take-up and fitted for either galvanometer or glow-lamp recording, the glow lamp being preferred because of its simplicity.

Noise-Reduction Unit for Glow-Lamp Recording.—A self-contained unit, either portable or for panel mounting, which provides polarizing voltage and noise reduction for glow-lamp recording. It has simple adjustments for setting the minimum and maximum current desired, and when these adjustments are set the unit is fully automatic. It is variable over a wide range and will give recordings from 5 to 25 ma. of current or from nearly clear negative to fully exposed negative. It has no time lag, can not react in any way with the amplifier, and may be connected to any amplifier.

Galvanometer for 35- or 16-mm. Recording.—An oil-damped galvanometer, so designed that each of its component parts is readily adjustable, making it possible to be fitted to almost any recorder. The galvanometer has a straight-line output to 10,000 cycles.

Projector for Background Projection.—A claw projector, noiseless in operation and rock-steady, designed for the extreme requirements of background projection. The claws have three teeth on each side, the tension shoes are long, with adjustable tension, and the wear on the film is a minimum. The mechanical parts are enclosed and lubricated by an oil pump.

THE SPECTROHELIOKINEMATOGRAPH

R. R. McMath
McMath-Hulbert Observatory, University of Michigan

Taking motion pictures of celestial phenomena that show change is not as simple as it would appear at first thought. This work was started in 1928, and in 1931 the instrumentation was donated by the founders of the McMath-Hulbert Observatory to The University of Michigan.

The combined tower telescope and spectroheliokinematograph of the McMath-Hulbert Observatory at Lake Angelus, Mich., is now one of the most powerful pieces of solar apparatus in the world. The optical train will be explained by means of slides, and then the apparatus itself will be illustrated by motion pictures. The second reel will show solar prominences in motion.

UNDERWATER CINEMATOGRAPHY

E. R. F. Johnson
Mechanical Improvements Corp.

The dates of the first recorded use of underwater photography and the tendencies toward its increasing use by producers are noted. The author's early experiences in this field are described. The opinion is expressed that for work in natural settings the most useful equipment consists of submergeable cameras placed on the bottom

and operated by divers. The rest of the paper deals with the problems of and equipment for such work. It is pointed out that studio tank work shares most of these problems.

The optical properties of water are described. Since water is less transparent than air, photography by natural light is limited to small depths and more power is required for artificial illumination under water. Since colors are not absorbed equally, accurate monochrome rendering and photography in natural color are complicated. Water haze limits the distance at which pictures can be taken under water. This haze is largely confined to a part of the spectrum and can be eliminated partially by color-filters. It is polarized and can therefore be eliminated also by polarizing plates.

The advantages of this method are briefly stated: they do not distort the monochrome rendering, and may be used in natural-color photography. The ideal attributes of equip ment for use in underwater cinematography are outlined and available equipment is briefly described.

IMPROVING THE FIDELITY OF DISK RECORDS FOR DIRECT PLAYBACK

H. J. Hasbrouck, Jr.
RCA Manufacturing Co., Inc.

Recent advances in equipment design and in materials of which recording disks are composed, have resulted in improved fidelity. Both the volume range and the frequency range have been extended, satisfying present-day requirements of motion picture and broadcast applications.

For reproduction, there is provided a new lighter weight lateral pick-up having high sensitivity and equipped with a permanent diamond point. This reproducer, in combination with its associated circuit, is suitable for use on all laterial-cut disk records.

Pre- and post-equalization are employed in the method described for making high-fidelity records, insuring an extremely low noise-level. This absence of background noise together with the wide frequency range and low overall distortion create an illusion of reality or "presence" during reproduction.

Usually a great many of playings are not required of direct playback disks. However, because of the low mechanical impedance of the new RCA pick-up and the improved composition of the disks it is possible to reproduce 75 to 100 times without appreciable increase in noise or distortion. Great differences in record life under various conditions of handling have been noted and are attributed chiefly to accumulation of fingerprints and dust on the record surface. Gradual oxidation of the lacquer coating must also be considered and guarded against by special care when records of this type are intended for long preservation.

REPORT OF THE STUDIO LIGHTING COMMITTEE

C. W. Handley, *Chairman*

In a previous report the need of a catalogue of studio lighting equipment was emphasized. A number of papers have been published which describe various lamps and light sources in detail, but there has not been assembled in one paper a symposium of all types of equipment and light sources. It is the intention of the Committee to correlate the published and unpublished data on motion picture studio light sources in such a form as to make this report a reference for complete information on the subject.

The various lighting units are numbered and briefly described. Photographs of popular lamps are shown. Tables give minimum and maximum beam divergences, carbon and bulb sizes. Journal reference numbers are given as a key to further specific information on any lamp or illuminant. Data on light control devices and lamp filters is included.

LATEST DEVELOPMENTS IN VARIABLE AREA PROCESSING

A. C. Blaney and G. M. Best

The purpose of this paper is to present a series of curves showing the photographic control of variable area sound tracks as obtained in commercial production at Warner Bros. Studio, and to show the wide tolerances in film processing which are permissible with Class-A push-pull recording, a factor which is of especial interest in connection with the daily production.

The results of a study of the technique involved in fine grain photographic duplicating of variable area sound track, for foreign release is also discussed.

THE M. G. M. SEMI-AUTOMATIC FOLLOW-FOCUS DEVICE

John Arnold

During recent years an important problem in major-studio cinematography has been that of following focus. Due to the shallow depth of field in modern lenses when used at maximum apertures, it is necessary to alter the focus frequently during the filming of a scene, to keep the actors properly focused. In moving-camera shots, which are being used with increasing frequency, this problem is naturally aggravated, since both camera and players may move. The use of "blimped" cameras for sound pictures also aggravates the cameramen's problems, as finder parallax is greatly increased by placing the finder outside the camera "bungalow."

At the Metro-Goldwyn-Mayer Studio these problems have been simplified by the use of the Semi-Automatic Follow-Focus Device. This consists of a finder which is both focused and pivoted to correct for parallax as the lens is focused. Individual cams coordinate the finder movement with the characteristics of any given lens.

So successful is this coordination that it is possible to determine whether or not an object is correctly focused in the camera by observing the object's focus and position in the finder. The device has been applied to all cameras used in production at the Metro-Goldwyn-Mayer Studio, and has over a period of several years proven to be accurate, dependable, and has facilitated production to a noteworthy degree.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933,

Of INTERNATIONAL PROJECTIONIST, published montbly at New York, N. Y., for October 1, 1937.

County of New York } ss.
State of New York

Before me, a Notary Public in and for the State and county aforesaid, personally appeared James J. Finn, who, having been duly sworn according to law, deposes and says tbat he is the Editor of INTERNATIONAL PROJECTIONIST and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc. of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on tbe reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, James J. Finn Publishing Corp., 580 Fifth Avenue, New York, N. Y.

Editor, James J. Finn, 580 Fifth Avenue, New York, N. Y.

Managing Editor. None.

Business Manager, Ruth Entracht, 580 Fiftb Avenue, New York, N. Y.

2. That the owner is:

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Ruth Entracht, 580 Fifth Avenue, New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving tbe names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

JAMES J. FINN, Editor

Sworn to and subscribed before me this 6th day of October, 1938.
(Seal) ALAN R. MOHLER

Notary Public, New York County Clerk's No. 550. (My commission expires Marcb 30, 1940.)

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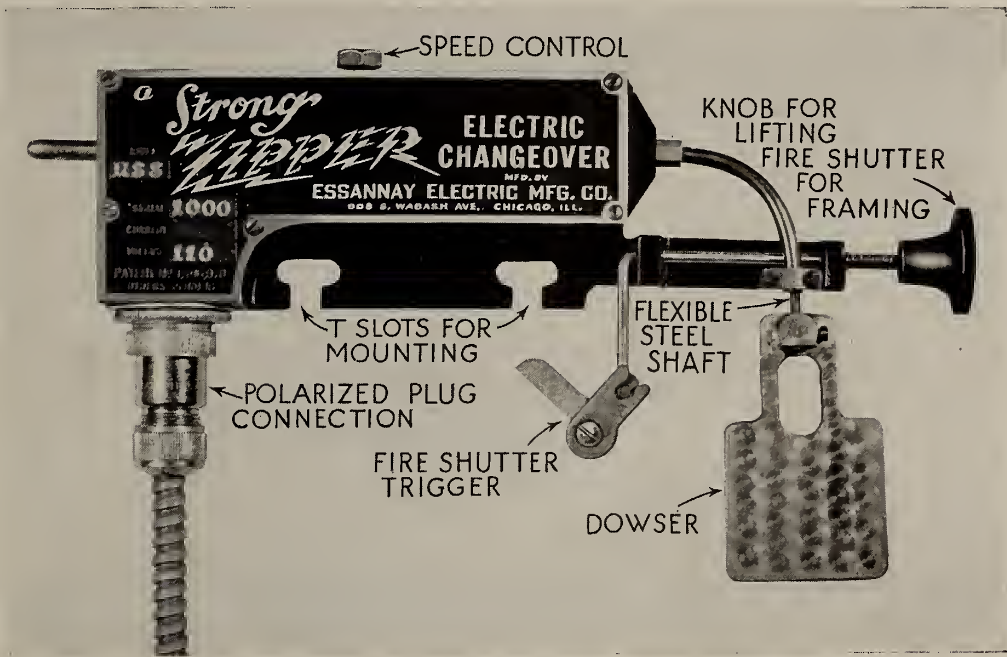

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INTERNATIONAL

PROJECTIONIST

NOVEMBER 1938

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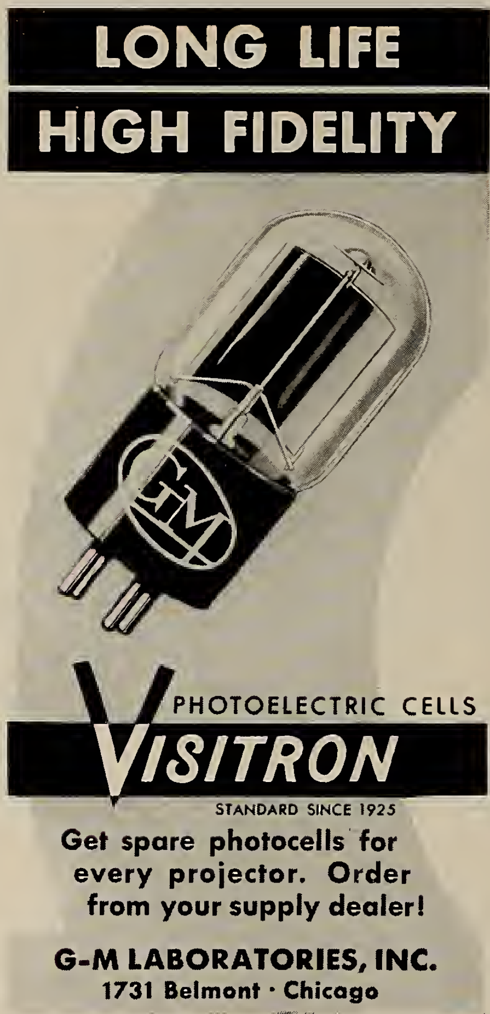
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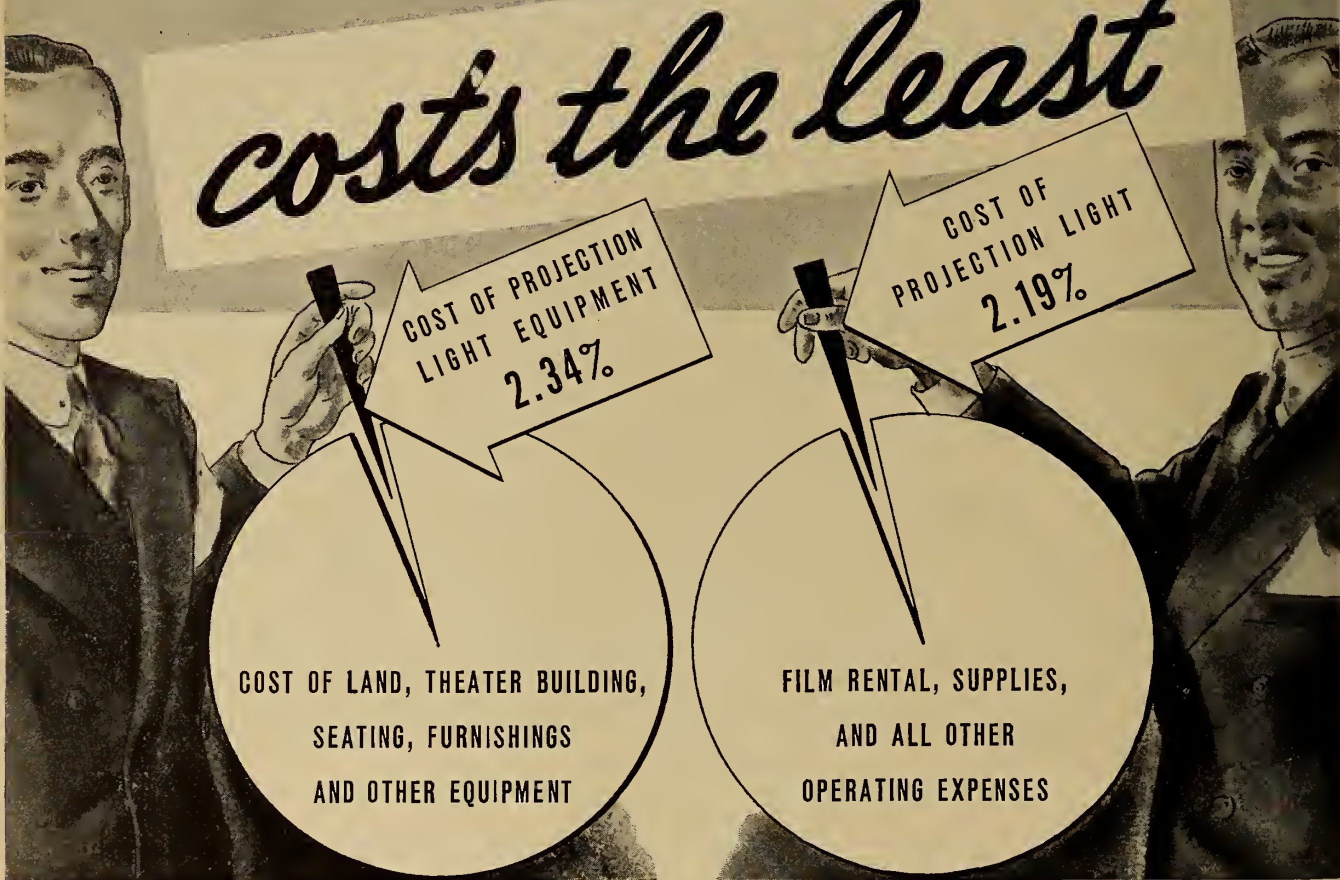

The entertainment which brings patrons to your theater night after night is, in the last analysis, just a rapidly changing pattern of light and shadow. The film which provides the shadow pattern is rented, but YOU provide the light. The quality and quantity of that light determines the effectiveness with which the picture is presented. The finest story and the most beautiful photography will often fail to please if poorly projected.

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Edited by James J. Finn

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Monthly Chat

TELEVISION, bugaboo of projectionists and exhibitors alike, will be the topic of great gobs of material now being assembled for the next issue. Commercial as well as technical phases of this new art will be detailed in this presentation, which while probably settling definitely few if any of the burning questions anent television now making the rounds, will undoubtedly contribute substantially to a clearer understanding of this electronic darling.

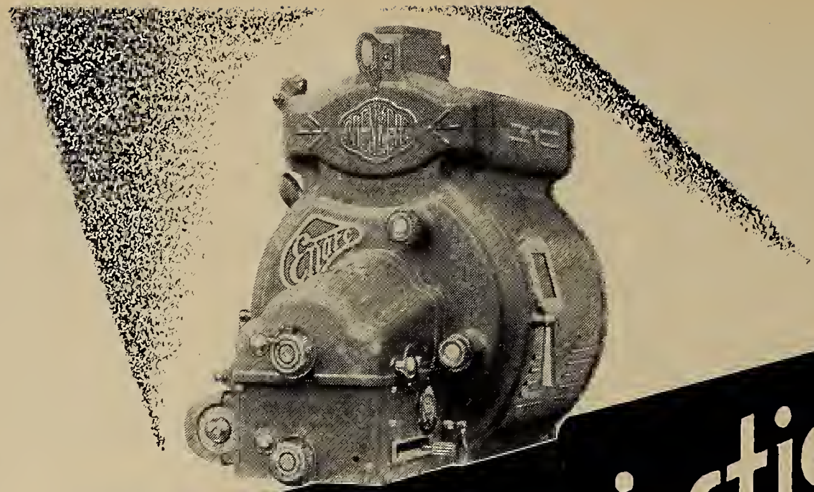
While we're on the subject of television, a word of warning to the craft: the woods are full of smart salesmen who are peddling television 'courses' which, as the art now stands, are about the most worthless expenditure a projectionist can make. Sponsors of such 'courses' know as little about television as does the average man in the street today—and considerably less than projectionists. Say 'No'—but loudly.

PROJECTIONISTS as a craft are deeply indebted to the National Tuberculosis Assn. for its tenacious fight against the "White Plague," which has attacked so many members of the craft. Assn. activities are financed through the sale of Xmas Seals. Pay off by buying these Seals.

LABOR in the motion picture field has exhibited little interest in the Government suit against the major producers and distributors which charges monopoly and a few other things. Failing to obtain a satisfactory consent decree, however, and pushing the case to conclusion might easily result in the establishment of a "commission" which would "supervise" the industry. Does anyone think that such a "commission" would overlook labor relations in this business? Such "supervisory" bodies inevitably find ways and means to paw around in all corners of an industry. We shall see.

EVEN a casual reading of the current report of the Projection Practice Committee of the S.M.P.E., published elsewhere herein, discloses why this is the standout committee in the Society. Revised room plans, an analysis of theatre structures, means for checking screen illumination, the safe handling of film—these are *practical* projection matters. Not forgetting that if ever there was a labor of love, this job is it. Congratulations to Chairman Harry Rubin and his co-workers.

OBJECTING strenuously to our remark that the smaller houses with low-intensity projection cannot possibly do justice to Technicolor prints, a correspondent cites a short throw and comparatively small screen area as reasons why he can project *any type* of print. We, in turn, are interested in that which our correspondent overlooked: How about the *color* of the l. i. light?



INTERNATIONAL PROJECTIONIST

VOLUME XIII NUMBER 11

NOVEMBER 1938

Advance Preparations Minimize Sound System Emergencies

By *AARON NADELL*

II. Resistors

EMERGENCY treatments involving "haywire" repairs, gadget substitutes for proper replacement parts and the like, never should be used in theatre work. However, there are few theatres, including the de luxe palaces, that have never been caught short of the right replacement, or never have been driven to some unorthodox but practicable remedy to keep a show going. That is true even where sound systems are installed in duplicate, and all exhibitors cannot afford double channels. Some refuse even to keep as many spare parts as they should.

When, if ever, a desperate remedy does become necessary, it is applied more quickly and is much more likely to be successful if it has been given a fair amount of thought and preparation in advance.

Emergency substitutes can be found for resistors more easily than for any other sound part. There are many ways of improvising electrical resistance. Improvisation is of course less justified in this case than in any other, since resistors are so cheap; but, on the other hand, a great many different kinds are used in every sound equipment, and the one that burns out may be just the one for which no spare is available.

The first advance procedure should be to check over the system diagram, listing all resistors by wattage as well as ohmage ratings. It will often be found that a number are exactly alike, or so nearly alike that they can be substituted safely for each other, with a corresponding reduction in the number of spares needed.

Resistor Combinations

Further study of such a list will show that some resistors can be replaced by series or parallel combinations of others, permitting a further reduction in the number of indispensable spares. In all such combinations, however, wattage ratings must be figured as carefully as resistance ratings. Overlooking that fact leads to burnouts.

When resistors are wired in series, add their separate values. Thus a 10,000-ohm unit can be replaced by two of 5,000 ohms each; by one of 7,000 and one of 3,000 ohms; or by a 5,000, 4,000, 1,000 combination, *etc.* All these are straight series connections.

The wattage requirements in this case are equally simple. If, for example, the original resistor carried 4 watts, then each of the 5,000-ohm series units will have the same current but only half the voltage drop, and each must therefore withstand only 2 watts. Similarly, the 7,000-ohm unit, having the same current at 7/10th the voltage drop, must be able able to take 7/10tb of 4 watts, or 2.8 watts. And so on.

If *smaller* resistance values, that can be added in series, are not available, the same effect can be obtained by using *larger* values connected in parallel. Thus the 10,000-ohm unit can be provisionally replaced by a parallel circuit containing two 20,000-ohm units. The current is now given two paths of twice the resistance each instead of one

path of lower resistance; the effect is the same.

With reference to wattage, note that in parallel connection each resistor is exposed to the full voltage drop, but carries only a part of the current, in this case, one-half. Replacing a 4-watt, 10,000-ohm resistor, two 20,000-ohm units in parallel need have only a 2-watt rating each. When resistors of unequal value are connected in parallel, the problem becomes only slightly more complicated, needing a few moment's work with pencil and paper.

Beginning with the familiar formula:

$$R = \cfrac{1}{\cfrac{1}{R_1} + \cfrac{1}{R_2} + \cfrac{1}{R_3}}, \text{ etc.}$$

the first step is to fill in real numbers for the R's wherever possible. Thus, if a 10,000-ohm unit is to be replaced, and there is, say, a 16,000-ohm unit at hand, the question becomes what else must be added in parallel to 16,000 ohms to make up an effective substitute? That question is then written:

$$10{,}000 = \cfrac{1}{\cfrac{1}{16{,}000} + \cfrac{1}{R}}$$

which by arithmetic of fractions becomes:

$$10{,}000 = \cfrac{1}{\cfrac{16{,}000 + R}{16{,}000R}}$$

$$\text{or } 10{,}000 = \frac{16{,}000R}{16{,}000 + R}$$

Thus far this has been a mere matter of adding fractions and then dividing 1 by a fraction. Now to clear the last fraction, both sides of the equation are multiplied by 16,000 + R. At the right side of the equation it is enough simply to cancel, since it is obvious that the same number first divided by 16,000 + R and then multiplied again by 16,000 + R must end up where it began. At the right side of the equation, therefore, the denominator is cancelled, and the left side is multiplied by it, giving:

$$160{,}000{,}000 + 10{,}000R = 16{,}000R$$

It is permissible to do almost anything to an equation so long as the same thing is done to both sides (preserving the balance) therefore the last result can be further simplified by subtracting 10,000R from both sides, leaving:

$$160{,}000{,}000 = 6{,}000R$$

from which it is obvious that R, the value desired, is 160,000,000 divided by 6,000, or 26,666. A 25,000-ohm unit should give sufficiently close results. This may be checked, as a matter of interest, by writing:

$$R = \cfrac{1}{\cfrac{1}{25{,}000} + \cfrac{1}{16{,}000}}$$

and solving as before:

$$R = \cfrac{1}{\cfrac{41{,}000}{400{,}000{,}000}}$$

that is, multiplying 25,000 x 16,000 to find the new denominator, and adding those figures to find the new numerator; then, chopping off the excess zeros and inverting:

$$R = \frac{400{,}000}{41}$$

which works out to 9,512—a fairly satisfactory emergency replacement for temporary purposes. In fact, about as good a replacement as could be expected from common commercial resistors, which are not warranted to be more than 95 per cent accurate.

If no 25,000-ohm unit is available, a 20,000 and a 5,000 ohm resistor might be wired in series to make one; so could units rating at 15,000 and 10,000 ohms. Only, if the last is available, why not use it as a plain 10,000-ohm replacement in the first instance, and save all the trouble? The answer to that is, fine, if the wattage rating allows.

See Fig. 2, representing a replacement for 10,000 ohms as just described, in which another 10,000-ohm resistor plays a minor part. The right-hand arm of the parallel circuit in that figure totals $\frac{25{,}000}{41{,}000}$, or roughly 3/5ths of the total resistance used, the left-hand arm having the other 2/5th. The current will divide inversely, 2/5ths flowing through the right-hand arm. The 10,000-ohm resistor in that arm therefore carries only 2/5th the current it would have if it were used singly as a straight replacement. Furthermore, constituting only 10/25th (or again 2/5th) of the right-hand arm, it must withstand only 2/5th of the voltage drop. Its wattage is therefore only 2/5 x 2/5 or 4/25, or less than one-sixth the wattage it would have to withstand if used as a straight replacement.

In planning spare resistor stock, simple circuits such as those of Fig. 1, the calculations for which can be done mentally in a moment, are obviously in order wherever it is desired to economize on the spare parts investment. It would just as plainly be out of place to build a spare parts investment on such arrangements as Fig. 2. What the latter does show is how (when caught by an emergency with a depleted spares inventory) it is possible to make use of such substitutes as can usually be found around a theatre, to avoid closing down.

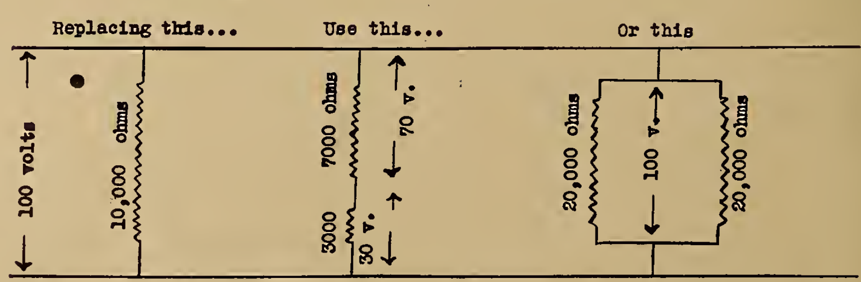
● Improvised Resistances

Figure 2 perhaps represents as complicated a resistance arrangement as any projectionist would care to use, although, of course, it can be varied indefinitely. However, it is often possible and even more desirable to improvise resistors. Almost anything that carries current or can be made to carry current (barring only copper wire) has enough electrical resistance to be used in some way or other in a tight squeeze.

Lamp bulbs, of course, are favored resistance substitutes. The 110-volt variety lend themselves to easy calculation by assuming them to be designed for 100 volts, in which case a 100-watt bulb carries 1 ampere at 100 volts, and has a resistance of 100 ohms. Similarly, a 50-watt bulb carries only ½ ampere, and offers a resistance of 200 ohms.

Lamp bulbs have saved many a show in emergencies. They have been used to cut down arc supply direct voltage for excitation of speaker fields when normal field supply methods failed, and similarly to provide d.c. for exciter lamps and for some vacuum tube filaments. Such "hay-wire" procedures, to the writer's knowledge, have been used even on Broadway to avoid an interruption of an hour or so; theatres more remotely located have through similar

FIGURE 1



means avoided closing down for days at a time.

Small signal lamp bulbs of the 2-volt to 18-volt variety can be used similarly, but here a precaution is necessary in determining their resistance. *The ohmmeter should not be used,* because the filament resistance when hot is not the same as when cold, and the ohmmeter will not provide enough current to heat it. Moreover, if the bulb has a tungsten filament, the resistance will increase when hot, but in the case of a carbon filament (which some of those small bulbs have) the resistance will be greater cold than hot.

Light the bulb normally, and use a voltmeter and ammeter to measure its voltage and current when heated; then figure the hot resistance by Ohm's Law. Used as an emergency resistor in which it will not be fully illuminated, the (cold) ohmmeter reading and the hot reading may be compared, and rough interpellation made of what the resistance will be at the current the bulb will normally carry in the circuit in which it is to be substituted. For more accurate determination, the same value of current can be passed through it experimentally, and the resistance at that temperature determined with the voltmeter and Ohm's Law. Exciter lamp and vacuum tube filaments can be and sometimes are used in the same way.

No lamp filament of any kind should be used in a circuit where it will be heated or partially heated if that circuit also carries sound a.c. Some distortion will result, perhaps to a serious extent. The changes in filament resistance that will follow fluctuations in sound volume may cause that form of substitute resistor to act either as a volume expander or a volume compressor, depending on the way it is connected.

Aside from lamp filaments, the projection room and the theatre always have on hand a number of materials that can be made to serve as substitute resistors. For very high values, as for the hundreds of thousands to millions of ohms used as "grid leaks" or grid resistors, pencil marks on paper have been used quite successfully. A thick black smudge of carbon is rubbed on paper with a No. 1 or even No. 2 pencil, and checked with the ohmmeter, the pencil adding or the eraser taking some away until the proper value is approximated. The method should be restricted to values of a half million ohms or more. For lower values the pencil lead itself has occasionally kept apparatus in operation.

Resistance improvisations can of course be combined with standard resistor units as per Figs. 1 and 2, for regardless of its nature the improvisation is electrically a resistor and can be treated as such.

A highly flexible variable resistor, capable of carrying substantial power, can be made with water to which salt

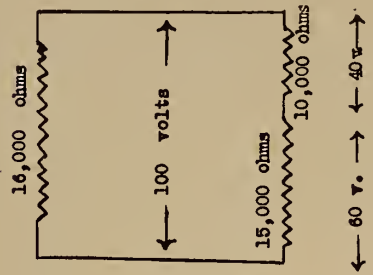


FIGURE 2

has been added in the proportion of about 2 lbs. per gallon. The salt must be stirred until it is thoroughly dissolved. For power work a galvanized bucket may be used; the bucket forming one contact and a heavy wire, insulated from the bucket but touching the center of the water surface, forming the other.

This arrangement is especially suited as an emergency motor starter, as in the case of sound system motor-generators still in use, or even the arc supply motor-generator within certain limits of starting current. The wire, touching the center of the water surface, is very slowly lowered to the bottom. The resistance of the water prevents excessive flow of starting current, that resistance decreasing as the wire is lowered and reaching zero with the metal-to-metal contact at the bucket bottom. The writer once operated a motor-generator for several weeks with that arrangement until a replacement starter resistor could be obtained, and found it very satisfactory. To assure permanent contact while the motor was running, the wire was weighted with a substantial No. 00 copper soldering lug.

● Improvised Rheostats

Small variable resistances, such as used for volume controls, filament controls and so on, generally have too high a resistance rating (too low wattage rating) for salt-and-water substitutes. For some of them, depending on the exact rating, it may be possible to use a pencil lead or an arc carbon, with a clip contact that can be moved about to provide the necessary variation.

In general, however, variable resistors do not go completely wrong; some one portion of them breaks down, creating an open or "short," while the rest of the unit remains usable. Consequently, whenever the range of variation need not be too great, it is usually possible to open-circuit, or physically remove, the defective portion, substituting a suitable fixed resistance for it, and continuing to operate on the good portion of the unit.

For example, consider a common type 100,000-ohm potentiometer as used for volume control in some amplifiers. Suppose an ohmmeter check shows that the portion remaining usable after breakdown totals 50,000 ohms. Cut away the other half, connect a 50,000-ohm resistor in its place, and the show can go on, with, however, somewhat diminished control over volume. Still, a poor show is better than none.

In making such connections, it is inadvisable to try to use solder, which does not hold very well on resistance wire and not at all on the carbon of which some such controls are made. The construction of the unit will suggest some purely physical method of clamping or fastening a contact, perhaps with the help of a drill and a nut and bolt.

One important point about such resistors is the "taper." Some of them have what is called "straight line taper"—that is, an equal change in the setting of the control will produce an equal change in resistance regardless of which end of the winding the control is working on. But others are tapered in various ways so that turning the knob ten degrees, for example, at one end of the winding produces a very different effect from a ten-degree adjustment at the other end.

If a replacement potentiometer or rheostat does not have the same taper as the original, it may prove impossible to secure sufficient sensitivity of control, and for the same reason it is impractical in emergency improvisation to try to use, say, half a defective unit on the theory that the good part will have half the total resistance. It may have 3/10ths or 7/10ths or some other fraction of the total resistance, in spite of being a fair half physically. The ohmmeter should always be used unless the taper is definitely known to be "straight line."

Wherever there is more than one variable control in a circuit, a defective control may be "strapped out"—shorted out—or replaced by an average value of fixed resistance, according to circumstances, and the second control used to obtain the necessary fine adjustment. Thus, in the case of a broken-down exciter lamp rheostat, strapping out may be entirely successful if the current is drawn from a rectifier equipped with a convenient means for varying its output voltage. Many sound systems mount a volume control on the front wall and another on the amplifier rack. If either goes wrong a suitable fixed impedance can be substituted for it, and the show worked by means of the other.

In filter networks, equalizers, and

similar tuned and semi-tuned circuits improvisation is largely ruled out by the nature of the circuit requirements; inductive reactance and resistance are both measured in ohms but they are not the same thing. Resistances which make up part of such circuits can be improvised, but reactances can be replaced only with others possessing an equivalent inductance as measured in henries.

Elsewhere in the sound system, however, impedance and resistance can be treated as approximately synonymous terms for purposes of emergency repair. (See Fig. 4, page 10, I. P. for Oct., 1938, in which a straight resistor replaces the inductive reactance of a transformer primary.)

One convenient and somewhat flexible source of emergency impedance is provided by the common projection room test phones. The most familiar type rate 2200 ohms a.c. impedance, provided by two receivers wired in series. Opening the connection to use one receiver alone therefore gives 1100 ohms; while changing the wiring to parallel connection makes a 550-ohm unit suitable for use in the 500-ohm transmission line which is standard in much sound equipment. Of course, some projection room phones are of higher impedance. The crystal type cannot be used at all as emergency substitutes for impedances that must also carry d.c., because electrically those units are condensers and d.c. will not pass through them.

The voice coils of spare speaker units are also serviceable in some circumstances. A roughly effective rule for determining the a.c. impedance of a voice coil is to measure the d.c. resistance with an ohmmeter, and multiply it by 1½.

Transformer windings are generally unsuited to emergency work, since the primary will possess its rated normal impedance only while the secondary is working into normal load and delivering normal current.

● Planning Improvisations

Even if the theatre stays dark for half an hour or so while an improvised repair is planned and put into effect, the result still is preferable to staying dark for hours or days while a replacement part is in transit, but delays can be minimized by doing a little planning in advance, coordinating the same with the normal contents of the spare parts box.

One vital factor, so far unmentioned, is the physical bulk of an improvised substitution in relation to the space available, and the necessity for running external leads if space is limited. External leads cannot be used in all cases; they may pick up hum or even cause feedback. Doubtless a show with slight hum in it is better than no show at all, but one of the functions of advance planning is to make sure that the spare parts budget is applied to those items for which improvisation is relatively impractical, leaving shortages only in the case of other items which can be, if necessary, substituted temporarily along the lines described herein.

The Mechanics of Motion Picture Projection

By *JAMES FRANK, JR.*

Numerous requests are made of I. P. by both individuals and organizations for a comprehensive exposition of the projection process that would serve as the basis for addresses, publicity work, *etc.*, directed to those outside the industry. The accompanying article was used by Mr. Frank for just such a purpose in an address before students of Hunter College, N. Y. City. It is the best job of its kind that we have seen.—*Editor*

PHOTOGRAPHY as an art began in 1825 in the form of still pictures. The first device constructed for projecting pictures in motion was probably the "Bioscope" invented by Duboscq in Paris in 1851, and a machine by Beale in England in 1854. In 1895 in this country Edison and Armat made decided improvements to the projecting device and made available the Kinetoscope. It is interesting to note that even at that time Edison was concerned with the synchronization of sound with the picture.

The motion picture projector in general use today is a highly developed device built with a greater accuracy than any other commercial piece of equipment.

The projection of motion pictures is made possible as a result of a physiological phenomenon known as the persistence of vision. When the light emanated by an object enters the eye, an image is formed on the retina, which is a membrane of the eye that can be compared to the sensitive plate receiving the image formed by the camera obscura. This retinal image has a certain permanency. It lasts for a short while before being cancelled by the succeeding image or by its natural elimination proper to the functioning of the eye.

● Persistence of Vision

This permanency or persistence of vision depends partly upon the intensity of the light that concurs to form the image, partly upon the intensity and character of the image that is going to supercede it. Newton in 1670 proved the physiological fact that the impression of the retina always lasts longer than the stimulus (source of light) and that if a new impression is allowed to be formed before the previous one is completely extinguished, an impression consisting of the blending of the two is obtained and, furthermore, that several impressions can be made to react simultaneously on the retina.

Investigation proved that the impression on the retina is not immediate. It gradually increases until it reaches a maximum and then gradually decreases to disappearance, so when stimuli are made to react on the retina even in rapid succession, they quite harmlessly blend into each other. The action of the retina is nevertheless extremely rapid, and the normal eye can perceive a flash of light of only 1/8,000,000 of a second. In such short duration the impression is not brought to the maximum ability of the retina to collect it, so that a light of low intensity, but long duration, makes a greater impression on the retina than a light of higher intensity but of extremely short duration.

In all apparatus dependent upon the phenomenon of persistence of vision the length of the stimulus must be sufficient to make its full impression on the retina and the intermittences must be of a duration sufficiently short to overlap the gradual decrease of the first with the increase of the second. It had been established that the most efficient duration of the stimulus in the presentation of motion pictures with the average light intensity of the projection arc is of approximately 1/50 of a second with an equal interval of darkness.

Thus we find the problem of projecting motion pictures in a theatre to involve the magnification and projection on a reflecting screen of a rapid series of successive still pictures from a small piece of celluloid film.

Up to 1927 when synchronized sound was commercially added, motion pictures were both photographed and projected at a film speed of 16 pictures per second or 60 feet of 35-mm. film per minute. In order to permit the addition

of the sound track with the required wide range of frequencies for high quality sound, the film speed was increased to 24 pictures per second or 90 feet per minute.

To project the picture a device is required which will move a long strip of film consisting of a large number of still pictures so that each picture comes to a complete rest in the film gate at the aperture opening where the light source is projected and then moves on to make way for the next one. Motion is imparted to the film by punching holes in each side of the film and employing sprockets which consists of cylinders with teeth around the periphery on either side which engage with the holes in the film. The design of the shape and spacing of the holes in the film and of the sprocket teeth as well as the diameter of the sprockets and their location is critical as it is desirable to eliminate any slippage or chatter that might be imparted to the film. Furthermore, as the film ages and is subjected time after time to intense heat it shrinks and steps must be taken to compensate for this.

● Intermittent Movement

The heart of a motion picture projector is known as the "intermittent movement," which part is used to accomplish the desired motion of the film. It permits each still picture to remain stationary for approximately 1/32 of a second and then moves it out and the next picture into its proper position in 1/96 of a second. The rate of pull-down is governed to some degree by the tensile strength of the film, which must not be damaged or torn for suitable results.

The intermittent movement consists of a sprocket on one end of a shaft whose teeth engage the film just beyond the point where the picture is projected. On the other end of the shaft, in an oil-filled sealed compartment, is a "star wheel" with four slots at right angles. On a separate shaft a "pin wheel" engages with the "star wheel".

The second shaft is driven from the non-operating side of tbe projector at a constant speed of 1440 r. p. m. and any irregularities are damped by a flywheel. While the pin travels the length of the slot and back the star wheel, and consequently the sprocket, turns enough to move one picture out of the film gate and to move another into its proper position for projection. During the time it takes for the pin upon leaving the slot to travel around and engage the next slot of the star wheel, the star wheel and the sprocket stand still. Thus it takes three times as long for the pin to travel around the pin wheel from one slot to the next than it takes for it to travel twice the length of the slot.

We have already noted that it is desirable to have the image of the projected still picture on the screen for approximately 1/50 of a second. It is also necessary to cut off the light projected to the screen while the film is actually moving to prevent any blur on the screen which would result if the light and picture image were continuously projected. For this reason a balanced two-blade shutter is employed to cut off the light during the period of film motion.

The blades are 93 degrees each and the shutter revolves approximately 1440 r. p. m. Thus, each still picture projected is cut off twice for approximately 1/96 of a second each, but the film moves only during one of the cut-off periods. The eye then sees 48 separate still pictures per second, each for 1/96 of a second, each pair being the same view, but they all blend into a continuously moving picture.

● Magnification Ratio

The size of the picture on the 35-mm. film is .600 x .825 inch. It must be projected and magnified onto a reflecting screen that in a theatre will vary in size from 8 x 11 feet up to 37 x 50 feet, depending on the size and shape of the theatre. This means a magnification of from 25,600 to about 55,000 times in terms of area. To accomplish this obviously means that a tremendous amount of light is required. Two other factors contribute to this problem. There is a loss of light due to its being cut-off for a part of the time by the shutter, and the lens that is required to magnify this picture to such a large degree absorbs a lot of light.

Light sources in general use consist principally of direct current arc lamps with reflectors which concentrate the light on the film aperture. Arc lamps of various intensities are available, each requiring power conversion apparatus of varying capacity dependent on the rating of the lamp. Provisions are made for automatically controlling the carbons so that as they burn they are kept in proper distance relationship for constant light intensity.

Carbons are designed for a burning period of about 25 minutes. Mazda lamps of the 1000 or 1500 watt variety are sometimes used in small theatres. The color content of the light is important, depending on the type of screen used in order that the final result be satisfactory contrast.

New S.M.P.E. President

E. ALLAN WILLIFORD

The head of National Carbon Co. will oversee film technical activities next year

The delicacy and accuracy of a motion picture projector can be best emphasized by simply pointing out a few of the problems involved. Up to the present time it has been found to be most economical for the theatrical field to use film with a nitrate base which is highly imflammable. 16-mm. film and special non-theatrical 35-mm. film is made with an acetate base which is non-imflammable. This requires the use of a fireproof projection room with certain protective devices. It also means that the projector must reduce the heat at the aperture as much as possible and that means must be provided to prevent film from stopping too long or piling up at the aperture, in which case fire would occur. Also, means must be provided to prevent fire from reaching the film storage sections or magazines of the projector if fire does occur.

By placing the rotary shutter between the light source and the aperture, the heat is reduced at the aperture about 50%. Even at that, the heat at the aperture may be of the order of 700 degrees F. The projector parts must be of materials that are not affected by that amount of heat. The shutter is a mechanically rotating device which has to be properly lubricated and must not vibrate if it is not to damage the machine. This is not an easy matter due to its proximity to the hot light source, which might cause expansion of the metal and vaporization of the lubricant.

● The Film Stock

The photographic image on a film consists of a very thin layer of emulsion on a celluloid base, the entire film being about 6/1000 of an inch thick. It is necessary to focus the image of the projected picture sharply on the screen due to the large order of magnification. Thus, while the film is moving through the film gate, means must be provided for accurately keeping the emulsion in one plane so that the film should not move out of focus at any time. At the same time, care must be taken not to scratch the emulsion in any way as tbe film must be used over and over again.

Keeping in mind the large magnification, a sligbt motion of the film in tbe aperture while the shutter is open, or even a slight motion of the projector due to vibration, becomes a large motion on the screen, which is, of course, intolerable, due to eyestrain. Since we cannot tolerate picture jump on the screen of over ¼ of 1 percent, it means keeping the film steady at the aperture in the order of tenths of thousandths of an inch.

These are but a few of the problems which make it necessary to adhere to tolerances of the order of 1/10,000 of an inch and to use especially selected metals

(*Continued on page* 21)

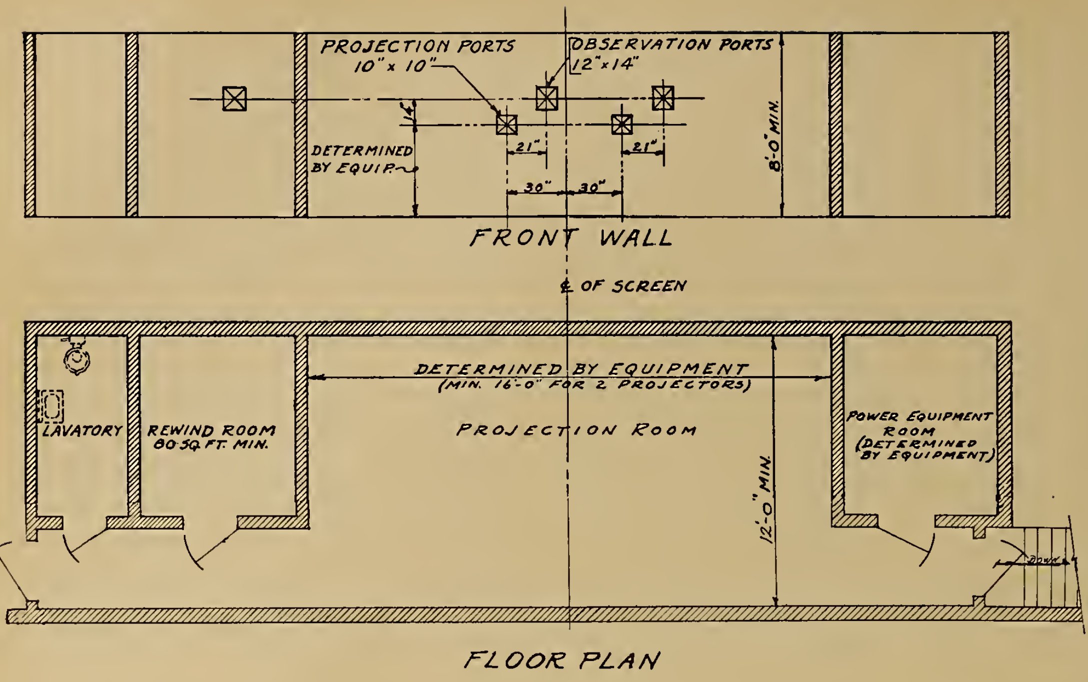


FIGURE 1

Functional diagram of projection and associated rooms, showing arrangement for two projectors

Theatre Structure, Screen Light and Revised Projection Room Plans

A REPORT OF THE PROJECTION PRACTICE COMMITTEE OF THE S. M. P. E.†

This report details the progress being made in what is undoubtedly the most ambitious program ever undertaken by the Projection Practice Committee. A preliminary report is rendered on theatre structure and screen illumination, while the revised room plans are given in full. Data anent the proposed revision of the NFPA regulations for handling film will appear in the next issue.

THE report of the sub-committee on Theatre Structures, comprising an analysis of a survey of theatres of the industry as regards their physical dimensions and structural proportions was published in I.P. for June, 1938. This report has aroused considerable interest among motion picture theatre architects both here and abroad. Although the work has not yet progressed to the point where the data of the survey can be used for determining ideal structural conditions for projecting and viewing motion pictures, the work is proceeding satisfactorily. The subject is a complex one and requires very careful analysis.

In connection with the rising interest throughout the industry in good projection and good viewing in motion picture theatres, the Committee has thought it advisable to state specifically its policy with regard to the view of the screen provided for each patron of the theatre.

The Committee regards clear and unobstructed viewing of the screen as an essential and major factor in audience satisfaction. It disapproves any form of auditorium design or seating arrangement that will prevent any patron from seeing all parts of the screen at all times, regardless of the positions of other patrons. There are several degrees of obstruction of view of the screen. Arranged in order of diminishing desirability, these are:

(1) Clear vision regardless of positions of patrons one or more rows ahead.

(2) Clear vision regardless of positions of patrons two or more rows ahead.

(3) Partially obstructed vision under almost any conditions.

To reduce obstruction of view, there are several methods available, including the following:

(*a*) Staggering the seats of successive rows (which may reduce the number of seats or cause "ragged" aisles).

(*b*) Raising the level of each row of seats relative to the row before it (which may lead to an impracticable amount of rise in some theatres from front to back).

(*c*) Adopting a suitable combination of fall and rise of successive rows of seats from front to back (which method requires further study in practice on a wider scale under various conditions).

One or more of these methods should be seriously considered by theatre architects. In no case does the Committee approve any seating arrangement falling appreciably below Grade 1 above; that is, the Committee disapproves any noticeable obstruction of the screen view of one patron by any other normally seated patrons no matter where located.

SCREEN ILLUMINATION

The product that the motion picture theatre offers to the public is the picture on the screen. The two essential factors in the production of a good screen picture are the film, over which the exhibitor has no control, and the projection light. It is only through the provision and maintenance of an adequate light-source that the management can exercise control over its product.

During the past few years theatre owners and managers have become light-conscious. This has brought about the necessity for a small, compact, portable, and inexpensive light-meter that can be as easily read as the ordinary voltmeter

† J. Soc. Mot. Pict. Eng. XXXI (Nov., 1938), No. 5.

or ammeter. With these considerations in mind the Committee sets out to determine the best type of meter obtainable.

There are three places at which the light might be measured:

(1) Directly in front of the projector. (2) Incident upon the picture screen. (3) Reflected from the picture screen.

The provision of a single instrument capable of making all three kinds of measurements was considered, and was rejected for the reason that such a meter, like all previous instruments, would be too cumbersome, complicated, and expensive for general use. On the other hand, a meter capable of measuring the light incident upon the picture screen fulfills the needs of 95 per cent of the light-measuring requirements. At the same time such a meter is both simple and low in price (Fig. 1A).

A meter of this type has been developed, with which is provided a visual correction filter which the Committee feels is essential to the accurate evaluation of light-sources in terms of human eye response. Tests with this meter calibrated in tungsten light at 3000°K showed that the errors, when measuring low- and high-intensity arc sources were less than 3 per cent.*

The meter reads from 0 to 30 foot-candles. It was felt that this range was ample for present commercial levels of screen illumination inasmuch as many theatres do not average more than 4 to 8 foot-candles, although the SMPE recommended average is about 10 to 20 foot-candles with the shutter running.**

In using the meter for measuring screen illumination, it is recommended that nine readings be taken as follows: At the center of the screen, at the four corners, and at the centers of top, bottom and both sides. When making a measurement the meter is held flat against the screen, the cell opening facing the projector, with the projector shutter running and no film in the gate.

These readings not only measure the incident light but also indicate the uniformity of distribution of the light, which is ordinarily expressed as the ratio between the readings at a side and at the center.

A ratio of 80 per cent is considered very good and is obtainable by manipulating the optical system of the projector lamp in a manner familiar to all projectionists.

PROJECTION ROOM PLANS

The projection room plans that follow represent the third revision of the plans originally published by the Committee in August, 1932. The second revision appeared in October, 1935. Such revisions are necessary from time to time in order to keep pace with the changes and developments in the art. The Committee urgently recommends the adoption of these recommendations by all architects and builders in designing and remodeling projection rooms so that greater uniformity of construction and greater efficiency in projection will exist in the future.

FIGURE 1A
Screen illumination meter

In following these recommendations, proper authorities should, in all cases, be consulted for possible deviation therefrom. Any fire-protection requirements specified herein are in accordance with the Regulations of the National Board of Fire Underwriters and the National Electric Code, which should be consulted for details.

Projection facilities shall consist of (1) the projection room proper, (2) a film rewind and storage room, (3) a power equipment room, and (4) a lavatory (Fig. 1).

● Projection Room Proper

(1.1) *Construction.*—The projection room shall be fire-proof, and shall be supported upon or hung from fire-proof structural steel or masonry. It shall have a minimum height of 8 feet and a minimum depth of 12 feet. The length of the room shall be governed by the quantity and the kind of equipment to be installed, but shall in no case be less than 16 feet. Consideration should be given to probable future needs.

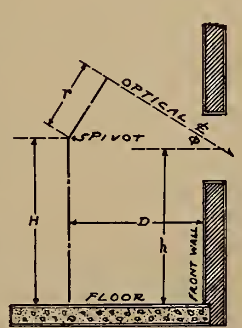
The Committee recommends that the projection room proper be so located with respect to the screen that the vertical projection angle shall not exceed 18 degrees. Optical axes of the projectors shall be 5 feet apart. When two projectors are used, the optical axes shall be equidistant from the center-line of the auditorium; when three projectors are used, the optical axis of the center projector shall be on the center-line of the auditorium.

(1.2) *Floor.*—The floor of the projection room shall be sufficiently strong and solid for the load it is to bear, and shall be constructed in accordance with local building regulations. A generous factor of safety should be allowed. A type of construction recommended by the Committee consists of (1) a reinforced concrete floor-slab not less than 4 inches thick; (2) a tamped cinder fill above the floor-slab, not less than 2 inches thick; and (3) a troweled cement finish above the cinder fill not less than 2 inches thick. Items (2) and (3) have been provided in order to accommodate concealed electrical conduits, which should be installed prior to placing the fill and finish. (See Sec. 6.1)

TABLE 1. SHOWING METHOD FOR LOCATING PROJECTOR PORT

$$h = H + rA - DB$$

(H) is the height of the center of the projector pivot from the floor: (r) is the radial distance of the optical center-line above the center of the pivot; (D) is the distance of the center of the pivot from the front wall of the projection room; (φ) is the angle of projection; and (h) is the required height of the center of the port from the floor of the projection room. Select the values of (A) and (B) corresponding to the angle of projection, and substitute in the formula



Projection Angle (Degrees)	A	B
0	1.00	0.00
2	1.00	0.04
4	1.00	0.07
6	1.01	0.11
8	1.01	0.14
10	1.02	0.18
12	1.02	0.21
14	1.03	0.25
16	1.04	0.29
18	1.05	0.33
20	1.06	0.36
22	1.08	0.40
24	1.09	0.45
26	1.11	0.49
28	1.13	0.53
30	1.16	0.58

(1.3). *Walls.*—The projection room walls shall be built of brick, tile, or plaster blocks plastered on the inside with ¾-inch cement plaster, or all concrete.

*Of the meters available for such measurements, the one tested by the Sub-Committee was the new Weston model 703.
**Actually 7 to 14 foot-lamberts.

The core of the wall shall be not less than 4 inches thick. When plaster block is used, it shall be supported upon steel framework. All electrical conduits shall be placed into masonry chases in the wall construction so that no pipes shall project beyond the main finish line. (See Sec. 6.1) In all cases, the inside surface of the front wall shall be smooth and without structural projections. (See Sec. 1.11.)

● Doors, Windows, Ports

(1.4) *Doors.*—A door shall be provided at each end of the projection room, at least 2 feet 6 inches wide by 6 feet 8 inches high. Doors shall be of the approved 1-hour fire-test type and shall be arranged so as to close automatically, swinging outwardly, and shall be kept closed at all times when not used for egress or ingress. It shall be possible at all times to open either door from the inside merely by pushing it. Door jams shall be made of steel.

(1.5) *Windows.*—Where a projection room is built against the exterior wall of a structure, one or more windows may be provided in the wall. Window construction shall be entirely of steel, and the glass shall be of the shatter-proof type. Metal adjustable louvres or other similar means may be used to exclude light.

(1.6) *Ports.—(General.)* Two ports shall be provided for each projector or single-lens stereopticon, one through which the picture is projected, known as the "projection port" (see Sec. 1.7), and the other for observation of the screen by the projectionist, known as the "observation port" (see Sec. 1.8).

The observation port shall be located above and to the right of the projection port. The distance between the horizontal center-lines of the projection port and observation port shall be 14 inches; the distance between the vertical center-line shall be 21 inches.

Where separate spotlight or floodlight machines are installed in the same projection room with motion picture projectors, not more than one port opening (see Sec. 1.9) for each machine shall be provided for both the projectionist's view and for the projection of the light, but two or more spotlights or floodlights may be operated through the same port.

(1.7) *Projection Ports.*—The finished ports shall be 10 x 10 inches, measured on the inside wall (Fig. 1).

The required height of the center-line of the projection port from the floor varies with the make and design of the projection and sound equipment and also with the projection angle. Manufacturers of equipment being considered for the projection room should be consulted for these dimensions. In no case shall any part of the projector be less than 4 inches from the front wall of the projection room. Table 1 lists two constants for various angles of projection which, when substituted in the formula, will permit calculating the height of the center-line of the port from the floor, when certain dimensions of the projector are known.

(1.8) *Observation Ports.*—The finished observation port shall be not greater than 12 inches wide x 14 inches high, measured on the inside wall of the projection room.

(1.9) *Other Ports.*—All other ports, such as for effect projectors or spotlamps, shall be as small as practicable, and in no case shall exceed 7½ square-feet in area per machine. The location of these ports will, of course, be determined by the dimensions of the equipment and the size and shape of the auditorium and stage, which determine the angles through which the light-beams must be projected. The dimensions should be obtained from the manufacturers of the equipment.

(1.10) *Ceiling.*—The ceiling shall be constructed of 4-inch concrete slabs or precast concrete, or of 3-inch plaster blocks supported by a steel structure and plastered on the inside with ¾-inch cement plaster. All wiring conduit in the ceiling shall be concealed (see Sec. 1.11).

(1.11) *Acoustic Treatment.*—It is recommended that an approved fire-proof acoustic material be used on the walls above a height of 4 feet from the floor and on the ceiling to reduce the transmission of noise into the auditorium.

● Rewind Room

(2.1) *Construction.* — The rewind

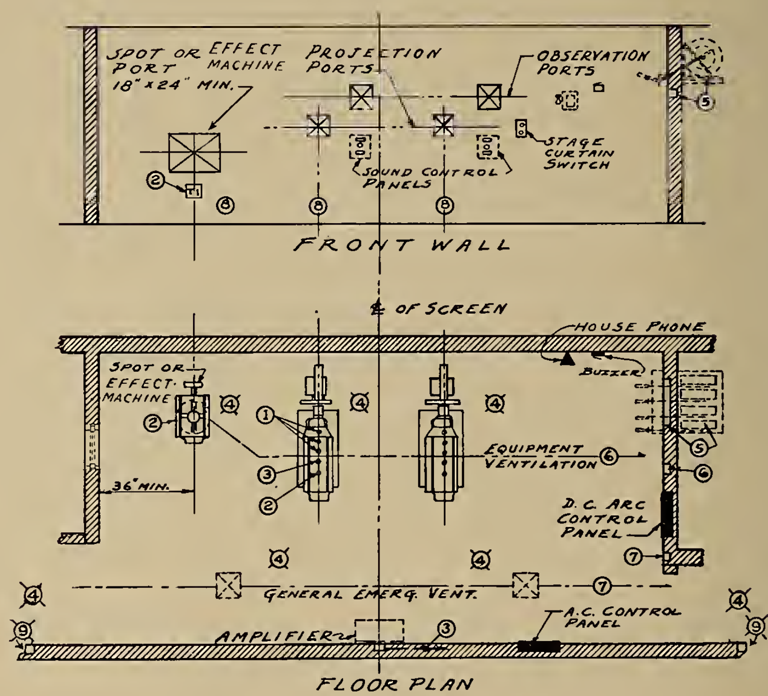


FIGURE 2

Projection room equipment, showing conduits, ventilation systems, lights, and switches.

(1) Three conduits in floor to a-c. control panel: for pilot light, change-over and motor feed, for both projectors.

(2) Conduit in floor to d-c. control panel and motor generator: for both projectors and spot (or stereo) via polarized plug-box on front wall of room.

(3) Conduit to pipe ground for each projector, and conduit to loud speakers on stage.

(4) Vapor-proof ceiling fixtures, and vapor-proof Reelites with wire guards for each projector and spot (or stereo).

(5) Dimmer and emergency lighting control.

(6) Projector and spot (or stereo) ventilation system and control switch.

(7) General ventilation system (normal and emergency), with switches inside and outside of doors of projection room.

(8) Wall receptacles.

(9) Wall switches, two-way type, individually controlling each ceiling light fixture from either entrance door.

room shall be of fire-proof construction. It shall have a minimum area of 80 square-feet (Fig. 1). (2.2) *Floor.*—See Sec. 1.2 (2.3) *Walls.*—See Sec. 1.3.

(2.4) *Doors.*—The door shall be of the approved 1-hour fire-test type, shall be arranged so as to close automatically, swinging outwardly, and shall be kept closed at all times when not used for egress or ingress. Door jams shall be made of steel.

(2.6) *Ports.*—An observation port shall be provided through which the motion picture screen may be seen trom within the rewind room. The port shall be at the same height from the floor as the observation ports in the projection room proper, as described in Sec. 1.6. (2.8) *Observation Port.*—See Sec. 1.8.

(2.9) *Other Ports.*—An observation window shall be provided between the projection room and rewind room, consisting of a fixed, fire-proof frame and polished plate wire glass. The window shall be not greater than 14 inches square. (2.10) *Ceiling.*—See Sec. 1.10. (2.11) *Acoustic Treatment.*—See Sec. 1.11.

● Power Equipment Room

(3.1) *Construction.*—The room shall be fire-proof and shall be similar in construction to the rewind room (with the exception of the openings (see Fig. 1)). The size shall be governed by the quantity and kind of equipment to be installed. Consideration should be given to probable future needs.

● Lavatory

(4.1) *Construction.* — The lavatory shall be provided with running water and modern sanitary facilities, with tiled floor and built-in flush-type medicine closet.

● Exits

(5.1) *General.*—Two exits shall be provided, one at each end of the projection room suite (Fig. 1), permitting direct and unobstructed egress, and shall conform to the regulations of local authorities. Any stairs communicating with these exits should have risers not in excess of 8 inches and minimum tread of not less than 9½ inches. The distance between walls should be not less than 36 inches. Winding or helical treads should be avoided. A platform equal in length to the width of the door shall be provided between the door and the first riser. Neither ladders nor scuttles or trap-doors should be used as means of entrance or exit.

● Conduits and Circuits

(6.1) *Locations and Sizes.* — Locations and sizes of conduits for projection, control, and sound equipment are determined by the type and design of the equipment. Manufacturers of the equipment should be consulted with regard to the proper layout and sizes of the conduit systems before floors, walls, and ceilings are finished (see Secs. 1.2 and 1.3). Conduits shall in all cases be concealed, and all boxes shall be of the flush-mounting type in walls and ceiling. Conduits terminating in the floors should extend 6 inches above the finished floor level.

Conduits and wiring should generally be provided for the following circuits:

(1) Projector mechanism: (a) motor (b) changeover (c) pilots.

(2) Projector arcs and spotlights: (a) rheostats, generators, or rectifier.

(3) Sound equipment: (a) a-c. supply (b) loud speaker circuits (c) amplifier and controls (d) ground wire.

(4) Projection room lighting: (a) general (ceiling and Reelites) (b) emergency.

(5) Theatre auditorium lighting: (a) dimmer (b) emergency.

(6) Projector ventilation equipment: (a) normal.

(7) General ventilation system: (a) normal (b) emergency.

(8) Miscellaneous: (a) stage curtain (b) telephone (c) buzzer (d) receptacles.

Figure 2 shows the general arrangement of the equipment requiring these conduits.

(6.2) *Projection Arc Supply and Location.*—In cases where the projection arc supply consists of rotating machinery generating acoustical hum or mechanical vibration, acoustical or mechanical insulation will be required. Arc supply equipment should be located in the power equipment room adjacent to the projection room, and at least four feet from any sound amplifier equipment.

(6.3) *Power Supply to Equipment.*—Where line-voltage variations are greater than ±3 per cent, the local power company should be requested to rectify the condition. In cases where it is impossible to maintain a steady line-voltage into the theatre, either manually controlled or automatic regulators should be installed.

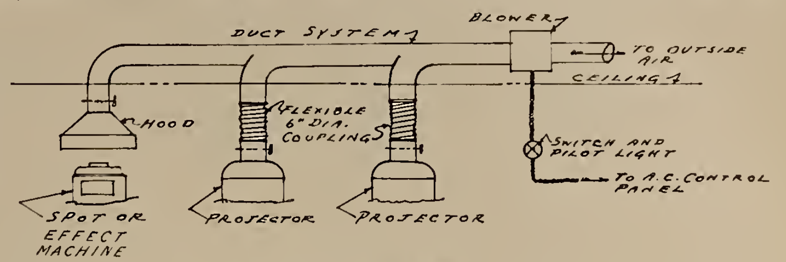


FIGURE 3

Equipment ventilation system: blower capacity 400 cu.-ft. per min.; minimum air movement through lamp houses with blower idle, 15 cu.-ft. per min.

(7.1) *Projection Room Lighting.*—Approved vapor-proof ceiling fixtures should be installed for general illumination, as indicated in Fig. 2, and arranged to be lighted on either the normal or the emergency lighting circuit.

An individual vapor-proof relight with wire guard shall be located near each projector or spotlamp, as indicated in Fig. 2.

All lights in the projection room and associated rooms, shall be shaded so as to prevent light from entering the auditorium through the ports.

(7.2) *Rewind Room.*—An approved vapor-proof ceiling fixture shall be installed for general illumination. A droplight or wall bracket fixture with approved vapor-proof globe shall be provided near or over the rewind table. These lights should be on a separate circuit from the projection room proper.

● Arc and Room Ventilation

(8.1) *Arcs or Spotlight.*—In permanent projection rooms, ventilation shall be provided for the arc lamps independently of the general end emergency ventilating system of the room. Each arc lamp housing shall be connected by a flue to a common duct, which duct shall lead directly out-of-doors and shall contain an exhaust fan or blower having a capacity of at least 50 cubic-feet per minute of air for each arc lamp connected thereto. This exhaust fan or blower shall be electrically connected to the projection room wiring system and controlled by a separate switch with pilot lamp within the room. There shall at no time be less than 15 cubic-feet of air per minute flowing through each lamphouse into an exhaust system connected to the air outside the building. Fig. 3 shows the general arrangement of the system.

(TO BE CONTINUED)

Reverse Prints Only A Minor Projection Problem

By *THAD C. BARROWS*

PRESIDENT, I. A. LOCAL UNION 182, BOSTON

THE current agitation anent the manner in which film is shipped to theatres seems to me to be much ado about practically nothing—a tempest in a teapot. While I have been extremely interested in craft opinion on this print question, it appears strange to me that other and more vital questions relating to print handling in exchange and theatre, and in transit, are glossed over and accorded little attention.

As one of the two or three people who strenuously opposed the introduction of the 2000-foot reel, I am amused to read now the remarks of those who almost ecstatically welcomed the advent of the longer reel. Proponents of the 2000-foot reel even went so far as to place their stamp of approval on the size, hub and gauge of metal to be used for the new reel, in addition to approving the new-type shipping case.

Now when all these changes have been effected, at great cost, those who were loudest in praise of the longer reel characterize exchange equipment, reels and cases, as wholly unfit for that service for which it was intended. I have no personal knowledge of the cost of switching to the longer reel length, but I certainly know from personal experience that the change not only did not settle any of the old problems but actually introduced a few new ones.

● Poor Quality Reels, Cases

Exchange reels, as all projectionists know, are wholly unsuitable for theatre use, and representative craft opinion frowns upon such a practice. The exchanges need have no fear on this score, however, because the damage to prints is already done by the time a shipment reaches a theatre. Some of the film cases now reaching theatres are so badly bent that a crowbar becomes an essential item of room equipment. Projectionists insist that exchange reels are unfit for use; still, the exchanges report that film is returned to them tails out—which indicates something definitely wrong somewhere.

I have found that Boston exchanges stand ready at all times to co-operate with projectionists and to correct shortcomings either in the print itself or in its handling. Moreover, the exchanges cannot be expected to satisfy the whims of some who in my, opinion haven't the slightest conception of the various problems that confront practical projecionists who work at the trade day in and day out. Armchair projection "executives" are not always close to problems of everyday theatre operation.

For years now film has reached theatres in reverse and otherwise, but nobody seemed to care a great deal about it. Suddenly the matter develops into a burning issue, with thousands of words being spilled *pro* and *con.* Why? It isn't such a gigantic task to reverse a print: one can rewind any feature without undue haste within fifteen minutes.

An attempt has been made in certain quarters to tag all projectionists with the "lazy" label—which is most emphatically not so. Those who are lazy, however, are referred to the literature of 25 years ago which mentions a magazine developed by Feaster which permits the running of film without rewinding until it falls apart.

● S.R.P. Shortcomings

Back in 1930 we adopted the Standard Release Print, which for a time served the projectionists well as a means for making better change-overs without loss of scene or sound. The gradual decline of the S.R.P. plan to a point where it hampers rather than aids the projectionist is a matter for deep concern on the part of all conscientious craftsmen. Repeated complaints anent the S. R. P. are ignored, while those who sponsored the plan and undertook the responsibility for its operation constantly push on to other projects.

Weary as I am of the theme, it still will do no harm, even if it does no good, to again cite glaring deficiencies in the S.R.P. Starting and change-over marks consistently appear on moving objects or on scenes so dark as to defy the most eagle-eyed projectionist; there occur numerous changes of scene between dots; dialogue is often carried to the end of one reel and immediately picked up on the one following—and, of course, Warner continues to wax prints.

Film so dense that not even 125-ampere high-intensity arcs can penetrate the murk are commonplace today. Footage of alleged "double" reels varies anywhere from 500 to 1850 feet—which circumstance makes even more amazing the hair-trigger cutting of dialogue between reels. With ample latitude of hundreds of feet of film the cutters still insist upon giving dialogue the closest shave in the world.

This is not an indictment of any particular company or companies: the aforementioned shortcomings are common to all distributors, although lax inspection is particularly evident in the prints of certain exchanges.

● More Important Issues

Why all the shootin' about reverse prints? If certain sections favor reverse prints, let them have them—depending upon subsequent developments with respect to exchange inspection. There is nothing so vital about the question of reverse prints as to occasion all the shootin' that has been going on. If projectionists really want an issue, let them concentrate on a really vital topic—improvement in the S.R.P., which, after all, concerns procedure *during* the show and not before or after.

Neither the producers nor their exchanges are particularly concerned about reverse prints—although the general adoption of such a practice might possibly lessen the exchange inspection burden. Nor do I think that projectionists should work up a lather about the question. If we as a craft really desire to improve the projection process, let us rear up and yell long and loudly about the obvious defects in the S.R.P. and about print density, which topics are infinitely more important to the art and which induce more headaches per unit of show than any other element in the process.

A Final Word on Reverse Prints; Topic Now Taboo in I. P.

The following excerpts from a letter regarding reverse prints raise several interesting points not previously mentioned. With the printing of these excerpts I. P. must close the discussion anent reverse prints. I. P. is inclined to agree with the view of Mr. Barrows that, the subject having been thoroughly aired, the adoption or rejection of the plan is one purely of local preference—with nothing to be gained by prolonging the discussion.—Editor.

May I cast a ballot in favor of reverse prints for our crew of three? Many projectionists either have given this topic too little thought or they do much unnecessary rewinding during inspection . . .

Projectionists continually complain about exchanges . . . Everybody who thinks anything of results would inspect all film before running. The time required depends upon the condition of the film: the poorer the print, the longer

the task. We all check for sound before running; why not check print condition?

Exchanges and film delivery people can't be blamed for all release print faults. Some projectionists must be guilty of misframed splices, breaks, punch marks and deletions. How about a little concern for the next fellow? Relative to remarks in I. P., we can't understand why one must rewind a print three times in order to inspect it and estimate its running time. Why rewind it even twice?

A reverse print requires but one rewind onto the house reels, including inspection. Any projectionist long at the business should be able to estimate running time to within 2%, even on the shipping reels. We have to do this, because a daily schedule must be set up shortly after we report for duty so that the newspaper may have the dope. We must be accurate.

I. P. mentioned marking running times on the bands. Last February we ran Hurricane and marked the running time of 105 minutes on the bands. Last week we ran this release again, and the exchange shipped us the very print we marked months ago. This time the print ran only 102 minutes! This same situation arose with an RKO print, the running time of which varied from 64½ to 60 minutes. What sense in marking the bands? Other projectionists must have thought we had brakes on our projectors.

A. R. Lalonde
Secretary, Local Union 341
Oil City, Penna.

Complete This Drawing and Win a Year's Subscription to I. P.

HERE is the second in a series of schematic diagrams which, having been altered in several respects, are offered as a practical aid in amplifier trouble-shooting and in familiarizing projectionists with circuit-tracing. This entry is a rather tough nut to crack by comparison with last month's drawing, which proved easy pickings for the boys. Not only is this current offering of very recent design but very few units have been distributed to date, thus making it unlikely that correct schematics will be readily available.

A couple of clues are given: (1) there are several errors in the diagram, and (2) disregard any internal tube circuit trouble. From here on, then, you're on your own.

Only subscribers to I. P. are eligible to compete. No consideration will be given to those answers which do not reach the offices of I. P. on or before December 26. All contestants submitting the correct answer will be given free a year's extension of their I. P. subscriptions. It is not necessary to enclose a copy of the diagram, although this is elective on the part of contestants.

Last month's diagram of a standard W. E. amplifier which is widely used was the softest touch yet, so soft, indeed, that its reproduction here would be a waste of space. It contained two errors—an open and a short—of such character as to occasion wonder that I. P. was not "taken" for a raft of free subscriptions. The open was found by practically every contestant; but the short was caught by comparatively few. No credit was given unless both errors were detected, as this indicated careful and intelligent tracing.

● Many Excellent Draftsmen

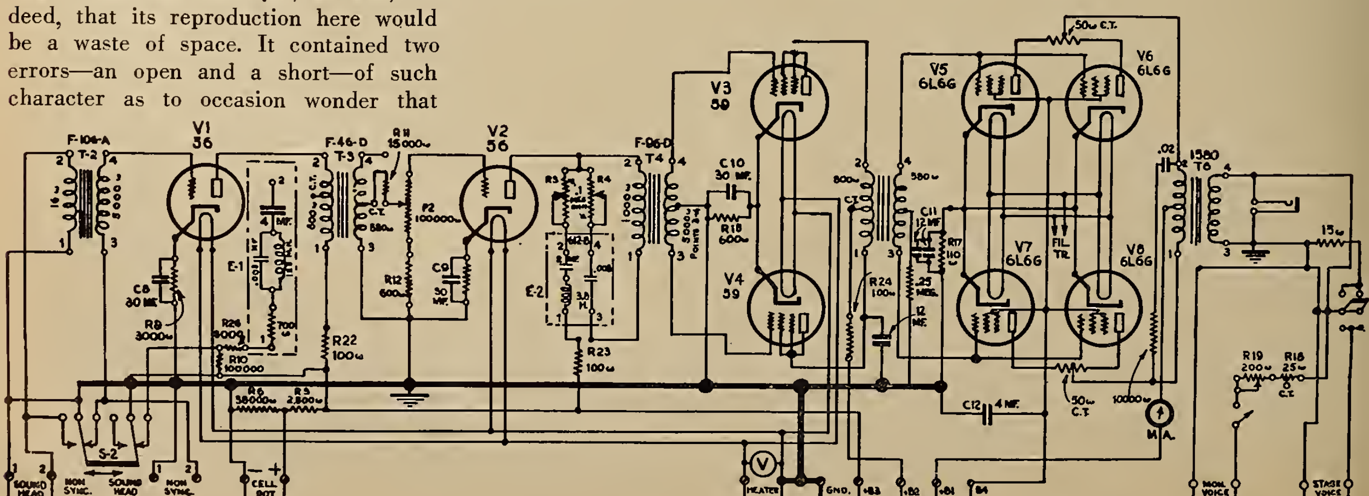
Some mighty fancy diagrams were submitted, so fancy, in fact, as to occasion surprise at the latent talent for freehand drawing existent among the craft. This wonder on our part, however, did not militate against anyone who submitted the correct answer. A couple of contestants stated frankly that they found the same diagram in a reference book and desired no credit for correct answers; they got it just the same, however.

I. P. apologizes to its readers for the positioning of last month's diagram. Many contestants remarked that they were reluctant to tear out the diagram because it backed up an interesting article. We shall try to avoid this mistake in future. Appended is the list of those who submitted correct answers, that is, those who found both errors and thus earned an extension of their I. P. subscriptions:

J. M. Burnett, Lynchburg, Va.; Gail DeJarnette, Dallas, Tex.; Philip Martin, Jr., Washington, D. C.; Chester A. Ellison, Reading, Mass.; Robb & Rowley Theatres, Inc., Dallas, Tex.; Russell A. Schrempp, St. Louis, Mo.; Jos. A. DeCaro, Mount Vernon, N. Y.; E. J. Doolittle, Baltimore, Md.; John F. Brownsell, Toronto, Canada; J. Carroll, Newburgh, N. Y.; F. C. Hartwick, San Francisco, Calif.

Also, H. Hartzell, Phillipsburg, N. J.; R. E. Anderson, Hickory, N. C.; Kay Kawachi, Los Angeles, Calif.; M. Rushworth, Baltimore, Md.; A. D. Kraatz, Corpus Christi, Tex.; C. H. Perry, Sudbury, Canada; E. G. Steele, Salt Lake City, Utah; T. Morisawa, Los Angeles, Calif.; R. B. Wingo, Corpus Christi, Tex.; E. C. Wiley, Galesburg, Ill.; James A. Day, Detroit, Mich.

Also, R. M. Hinshaw, Weiser, Idaho; R. A. Godfrey, Macon, Ga.; J. T. Kirkham, Calgary, Canada; Eugene W. Smith, Dallas, Tex.; George J. Beltz, McMechen, W. Va.; Chas. A Pearson, Corpus Christi, Tex.; Ralph W. Rushworth, Baltimore, Md.; Herman Polies, Miami, Fla.; James A. Zachritz, Cushing, Okla., and H. E. Annett, Sault Ste. Marie, Canada.



British Projectionists' Educational Program

By *JACK HOLLIDAY*

MEMBER, GUILD OF BRITISH PROJECTIONISTS AND TECHNICIANS

Here is a most interesting contribution anent the educatioonal work carried on by British projectionists. Except for similar activities by the Florida State Assoc., Cleveland, St. Louis, San Francisco and a few other units, the American craft can point to no such consistent record in the educational field.

AN EXCELLENT article published in I. P. and reproduced in the *Journal*, official organ of the Guild of British Projectionists and Technicians, entitled "Outline of the Requisites for a Component Projectionist"[1], by A. C. Schroeder, seems to me to show that matters in the United States, as far as actual technical knowledge among projectionists is concerned, appear to be much about the same as in England. To be fair to a large number of the fellows, the need for education has been apparent, but the means of getting it has been the main difficulty, as it is not everyone who can make a success of self-study.

Perhaps I. P. readers will be interested in the work done in this direction by members of the Newcastle upon Tyne (England) Court of the Guild, whereby it has been made possible for every projectionist in the district to attend morning classes. Through the efforts of three Guildsmen, Alf Brown, Fred Mitford and Jack Holliday, a three-year projection course was commenced in September, 1937, at Rutherford Technical College, Newcastle. Alf Brown, chairman of the local Court of the Guild, is an outstanding British projectionist, his provocative articles being well known in the trade press. An expert in photography, his slides are a joy to the eye. His aides Fred Mitford and myself, have had many years of projection experience.

The syllabuses of the various sections of the course given herein will be seen to be very comprehensive, and it will be generally agreed that they provide a thorough grounding in the technical side of a projectionist's business. The third-year syllabus, not yet drawn up, will consist of a course in wireless engineering, modified to suit the requirements of the projectionist.

● 'Decimals', not Decibels

Here is a true story (I shan't mention any names, the fellow may have some pals in America!) which goes to show how lack of knowledge may lead a man to unwittingly make a fool of himself. A junior, young and thirsting after the "whys and wherefores" of everything, asked his chief, "Is it correct, Mr. So-and-so, that the fader is designed to give an increase of two and a half decibels per step?" Putting on a superior air (ignorant people always seem to do this) Mr. So-and-so loftily replied, "Not decibels, my lad, *decimals!!*"

Gone forever was the respect that every junior should have for his chief, and away went some of the boy's enthusiasm too, for he thought, rightly or wrong, that if the other was getting by without knowing, there didn't appear to be any necessity for him to continue burning the midnight oil over his books.

● First Year Course

Calculations.—Simple algebraic evaluations and arithmetic calculations. Graphs, including distance-time and speed-time graphs and calculations. Vectors-sum and difference. Velocity and acceleration, Force and Mass. Practical and c.g.s. units.

Electrical Engineering.—Properties of matter. Static electricity, conductors and insulators. Electron theory, structure of the atom. Law of charges, electroscope. Effects of electric current, practical applications, chemical effect coulomb and ampere. Ohm's Law. Resistance. Series and parallel grouping, regulating resistances. Chemical production. Simple and primary cells. Accumulators, maintenance and installation. Magnetism, magnetic fields, including straight and circular conductors, practical applications. Heating effects-calorie, Joule's equivalent. Power and energy. Electromagnetic induction. Lenz's Law. Ammeters and Voltmeters.

● Second Year Course

Light.—Light travels in straight lines; production of shadows. Intensity of illumination, photometry. Laws of reflection of light; reflection at a plane surface; production of image; multiple images. Properties of spherical mirrors. Laws of refraction of light. Internal reflection. Refraction through a triangular prism. Dispersion of light; the spectrum. Properties of lenses. Optical instruments; the eye; vision.

Sound.—Nature of sound. Vibration, wave-motion. Velocity of sound, reflection of sound, echoes. Vibration of strings, rods, columns of air; nodes and antinodes. Resonance. Musical notes, pitch, loudness, quality. Musical intervals, harmonics.

Electrical Engineering. — Resistivity, influence of temperature. Simple distributing schemes, cables. Use of the Institute of Electrical Engineers' tables for cables and fuses. Magnetic properties of materials, simple calculations on magnetic circuits. Electric lamps, arc lamps, photometry. Application of Faraday's Law and Lenz's Law to motors and generators. Elementary study of a.c. circuits and machines. I.E.E. wiring rules, types of installations, cinema and workshop schemes. Switching arrangements.

First-year students attend the college every Tuesday morning from 9:30 to 12:30 a.m. during the term, and second-year students attend at the same times on Fridays. As the College is municipally-owned, fees are very low and work out, in American currency, to the equivalent of $2.50 for the first year and $4.50 for the second year.

[1] I. P. for Jan., 1938, p. 9.

Permanent Magnet Speakers Gain Favor

MANY projectionists, noting the increasing use of permanent magnet speakers in the sound motion picture field, are puzzled as to the reasons underlying the selection of this type of unit. We all remember the horseshoe magnets which were popular years ago and to which would adhere innumerable steel articles. Although these magnets did not have a uniform degree of magnetism and required a "keeper," or steel bar, across its poles when not in use, it retained a high degree of magnetic strength for a surprisingly long period.

Metallurgical science has since given us a vastly improved magnet which furnishes the driving power for loudspeakers. This magnet has been made possible by an improved metal—by name, Alnico—which, possessing proper quantities of aluminum, nickel and cobalt steel, has the following advantages:

1. It may be more heavily magnetized than any other known metal, thereby possessing greater magnetic strength for a given mass.

2. It has perfect magnetic retention characteristics—the ability to maintain magnetic strength for an indefinite period.

3. It may be magnetized to a definite degree of flux density.

4. Its magnetic efficiency remains constant under all conditions—affording precision performancee.

● Win Navy Approval

These desirable characteristics were, in a large measure, responsible for the exclusive adaptation of permanent magnet loudspeakers by the Bureau of Engineering, U. S. Naval Department, for nowhere is equipment subjected to more severe application than in the naval service, where it must withstand extremes in climatic conditions and where ruggedness and dependability are vital factors.

While field energized loudspeakers

enjoy a degree of national acceptance, they must employ a power unit for field excitation supply. It must deliver a source of pure direct current to avoid troublesome a. c. hum. This power unit must employ transformers, choke coils, condensers and rectifier tubes—all electrical parts which are subject to definite life or premature failure. Then, too, energized speakers lose efficiency as they warm up in operation, performance varies with the line voltage supply, and the unit constantly depreciates with the aging of the rectifier tube. All these factors render questionable the exact degree of operating efficiency.

The foregoing summary of field energized speakers, their particular characteristics and operating vagaries should remove any further dilemma concerning their relative values in comparison with the permanent magnet type.

Probing The Secrets of Tuberculosis

By *DR. H. E. KLEINSCHMIDT*

DIRECTOR, EDUCATION SERVICE, NATIONAL TUBERCULOSIS ASSN.

Pulmonary ailments are a definite occupational hazard of projection work. The activities of the National Tuberculosis Assn. in fighting the dreaded 'White Plague' have proved of inestimable benefit to many members of the craft. These activities are financed through the sale of Xmas Seals. That is why I. P. considers it a privilege and a pleasure, if not a duty, to again donate advertising and editorial space to the annual Xmas Seal drive. That is why, also, projectionists should support the Xmas Seal drive to the utmost.—*Ed.*

UNDER the most powerful microscope, the germ that causes tuberculosis looks like a short, red rod, smaller than the first joint of a housefly's leg would look to the naked eye. Yet we know that that speck of matter (it would take 30,000 laid side by side to make one inch) is a living creature which runs its life course and carries on its species. The life habits and peculiarities of this organism have challenged the interest of scientists. What is it made of? How does it grow and reproduce and what are the poisons it excretes?

To find the answers to these and other questions, the Committee on Medical Research of the National Tuberculosis Assn. started, in 1920, its work of analyzing the tubercle bacillus. First it was necessary to have a sufficient supply of germs, for to analyze a single one would obviously be impossible, so a method was devised for growing them in huge quantities—by the quart. Then the germs had to be broken down into their chemical elements—a slow and tedious process. Each element or fraction had to be tested on laboratory animals to see just what effect it had on living tissues.

● The Tubercle Bacillus

All this was done not by a single worker, but by a number of workers in laboratories in various parts of the country. To each laboratory is assigned a special task by the Committee, and from time to time their findings are correlated.

Today we know that the tubercle bacillus consists of the same basic materials that go into the making of a tree, a fish or a man—namely, proteins,

sugars, fats and salts. We know in general that the fats of the tubercle bacillus cause the body cells to wall off the germs into tubercles; that the sugars are responsible for the fever and that the proteins act as a poison. Each of these substances has been broken down into smaller fractions and bit by bit the structure of the tuberculosis germ is being put together much like a jig-saw puzzle.

This is but one example of the type of research work now going on to find the answers to age-old questions. There are others just as romantic. For instance, what is the life cycle of the single bacillus like? To find out, it is necessary to isolate a single bacillus and study it apart from its millions of fellows found in the test tube.

This is like isolating a single person from a great metropolis like New York and placing him in a glass room where his individual actions can be studied. Incredible as it may seem, laboratory workers have succeeded in finding a way of cornering a single bacillus in a drop of fluid. This drop hangs on the bottom side of a glass slide where it can be studied with the microscope.

The next step was to devise a motion picture apparatus with a special lens and to train it on the drop so that successive exposures might be made at measured intervals of time. Six months of patient photography went on before a single picture turned out clear; but it was worth the trouble, for the series of pictures that was at last secured is more thrilling than any drama acted by human beings. The single germ grows. Soon there are a string of tiny rods. A few hours later there is a swarm bending, twisting and mulling around grotesquely—such a sight as one might see on the streets of a busy city viewed from an airplane. Through this study much is being learned about the nature and habits of the tubercle bacillus that was never known before.

Twice each year the men and women who do this research work get together for a conference. Each tells what he has done and each new bit of evidence is fitted into the whole pattern. Then plans for the future are discussed. This, the modern method of research work, is called the "jury system." It is less expensive than setting up a special laboratory and far more elastic. Specialists of all kinds may be drawn into the jury circle when, and if, their highly expert services are needed.

The job of planning the project and of giving it leadership is financed *by the money that comes from the sale of Christmas Seals.* Thus, everyone who buys a single Seal has a share in the fascinating game of searching out the secrets of tuberculosis—the enemy who has for so many generations brought misery to the human race.

Offer Special Discount on Academy Sound Book

A special discount of 40% is being offered by the Academy of M. P. Arts & Sciences to I. P. readers on the book "Recording Sound for Motion Pictures". Although published originally in 1931 and somewhat superseded by subsequent developments in the art, this book is more general and less technical than other recent works and contains a wealth of information which still is of much value as a reference.

Running to 404 pages and having 235 illustrations, this book would make a valuable addition to any technical library. The original price has been cut from $5 to $3, plus 25c. postage to anywhere in the U. S. or its possessions. Only a few hundred copies are available at this low price. Address orders to the Academy in the Taft Building, Hollywood.

Canadian Unit Victor in Manpower Battle

The bitter battle waged between British Columbia (Canada) projectionists and exhibitors over Provincial regulations anent room manpower has resulted in a sweeping victory for the former. The fight was precipitated by the efforts of exhibitors to substitute in theatres having "approved automatic fire-extinguishers" an apprentice in place of a licensed projectionist.

Local Union 348, of Vancouver, fought the exhibitors to a standstill by engaging in intensive widespread publicity work, and at one time declared a general strike throughout the Province.

The new manpower clause now reads: "In every moving picture theatre equipped with two or more kinematographs there shall be at all times in the projection room when the theatre is open to the public, two licensed projectionists holding certificates of competency . . ."

THE MECHANICS OF MOTION PICTURE PROJECTION

(Continued from page 11)

for each part, many of which are hardened and ground.

Because of the fire hazard 35-mm. film may not be stored in lengths in excess of 2000 feet per reel. This length of film provides about 22 minutes of show. Thus a feature picture might consist of 4 or 5 such reels, whereas short subjects and news reels consist of 1. For a continuous show, therefore, two projectors are used, shifting from one to the other. The reel of 2000 feet of film is placed at the top of the projector. The film is caused to move by a number of sprockets downward winding it up on another similar reel at the bottom of the apparatus. The take-up reel is driven at a varying speed, depending on the amount of film on the reel in an attempt to wind it up without allowing undue slack at any time.

● Projector Operation

In the projector mechanism there are two sprockets in addition to the intermittent sprocket. One at the top draws the film out of the upper reel and guides it toward the film gate. The other at the bottom guides the film to the soundhead attachment or lower magazine as the case may be, filters out any jerks or uneven motion which the lower magazine reel may cause, and maintains a loop of film between it and the intermittent sprocket, since they all turn at exactly the same speed, so that the intermittent motion is pretty well smoothed out by the time the film leaves the mechanism. Guide rollers hold the film against each sprocket.

A micrometer focusing device permits accurate control of the projection lens. Another control permits the film to be moved up or down so that it may be properly and accurately centered in the aperture. It is necessary to maintain a fixed relationship between the revolving shutter and the intermittent movement to insure the light being cut-off during the entire period of pull down. If this adjustment is not accurate, distortion occurs on the screen.

A control is provided so that the proper relationship may be easily accomplished. Wear of the gears will affect this important relationship so that provision is made for easily enlarging the size of the shutter to maintain the high standard of projection. A fire shutter is located on the light source side of the aperture operated by a governor so that as the projector slows down the shutter closes preventing the film from igniting.

The projector is driven by an alternating current motor, in most cases, at an accurately constant speed. Provision is made for smooth starting to facilitate changeover from one reel to the next and to prevent damage to the projector or the film.

For changeover from one projector to the other, when the film on the upper reel is nearly used up, the projectionist lights the arc lamp of the second machine. Two cue marks are placed on all films near the end of each reel in the form of dots at the upper right corner. The projectionist watches for them on the screen, and upon seeing the first starts up the second machine. When he sees the second one he opens up the light on the second machine and simultaneously cuts off the light on the first machine. He, of course, changes over the sound too by throwing a switch. He has previously determined how long it takes his projectors to get up to full speed so that he can thread his film in the projector with just the right number of inches of blank film in the front of each reel for proper changeover.

The screen must have a high reflective characteristic without causing glare. The light must be uniformly distributed over the entire picture area. Screens of various reflective qualities are available for theatres of various widths. Because it

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is necessary to place the sound system loudspeakers behind the screen to maintain proper illusion, modern screens are perforated in such a way as to permit a major portion of all of the audible frequencies to pass through them, and yet to reflect a very large portion of the projected light. A major problem is also to provide screens of large area without objectionable seams running through them.

Up to this point in our discussion, we have considered only the projection of the picture and how it is done, as well as some of the problems involved. This is but a part of the story. We still have to reproduce the sound. The steps are to convert the light waves, that are created by projecting a sharply focused beam of light through the sound track on the film, into electrical waves by means of a photo-electric cell. These may be amplified and converted into sound waves by a loudspeaker which must direct the sound into the theatre auditorium so that every auditor hears the same high quality of sound.

Sound Reproduction

One of the most fundamental requirements of sound on film recording and reproduction is that the film be caused to move at an accurately constant speed in both processes. The speed of 90 feet per minute previously mentioned is the slowest practical speed which will permit sound of the high quality required. The problem in the projector is complicated by the fact that intermittent motion is required for the projection of the picture. For this and mechanical reasons the sound track is printed on the film approximately 20 inches ahead of its respective picture. This permits the placing of the sound reproducer or soundhead attachment below the projector mechanism between it and the takeup magazine.

The path of the film through both units is such that the sound track is scanned at precisely the same moment that its respective picture is being projected. It then becomes necessary to smooth out the motion of the film from an intermittent one in the projector mechanism to an accurately constant one in the soundhead in a film path of about 20 inches. This is accomplished by wrapping the film around a hollow drum at the scanning point, with the sound track portion extending beyond the end of the drum. This drum, driven by the film, causes a hollow cylindrical compartment on the other end of the shaft to turn. Inside this compartment is a free moving heavy mass on a precision ball bearing. The balance of the compartment is filled with a special oil.

As the drum and compartment are caused to rotate by the film, the heavy mass is set in motion through the viscosity of the oil. Any irregularities of film motion are promptly damped out by the heavy mass through the oil to the compartment. A constant speed with irregularities of less than ½ of 1 per cent is possible with this device. Two sprockets are located between the drum end and the takeup magazine.

The first is an accurate sound sprocket which draws the film down over the drum and yet after it gets up to speed maintains a free loop between it and the drum to prevent any possibility of imparting any sprocket tooth chatter to the film at the scanning point. The second sprocket maintains a loop between it and the sound sprocket to prevent the possibility

of any irregular motion of the takeup film reel being imparted to the film at the scanning point. The soundhead and projector are mechanically connected in such a way that the sound head drives the projector.

Let us assume that we have already photographed the image of the sound track on the film alongside the picture and that the combined release print for projection and reproduction is available. To create the varying light waves for the sound track, a constant source of light, known as an exciter lamp, is located in the soundhead attachment. Through an optical system which includes a mechanical slit this light is sharply focused on the emulsion of the film at a point where it is wrapped around the drums as an intense image approximately 1/10 of an inch wide and 1/1000 of an inch high. The sound track is located on the right-hand side of the film between the picture and the sprocket holes.

Already mentioned is that the sound track portion of the film overhangs the hollow drum so that the light passes through the film at that point. With the film in motion, the light emanating from the other side of the film varies in intensity in relation to the amount that is cut off and transmitted by the soundtrack. Thus varying light waves which are directly proportional to those which originally were exposed to the negative film in the recording process are created. These varying light waves are directed by a prism to the photo-electric cell.

● Function of P.E. Cell

The photo-electric cell is one of the most important features of a sound reproducing system. It has been found that certain metals have the property of emitting electrons when light is directed at them and that the number of electrons emitted bears a direct relationship to the intensity of the light. Further investigations proved that by placing these metals in either a vacuum or in a container with an inert gas, this characteristic was amplified.

The type of photo-electric cell used with sound reproducing systems consists of a conclave cylindrical cathode on the surface of which is placed a layer of caesium about one molecule in thickness. This cathode is placed in the center of a vacuum tube with a glass envelope. A plate is located near the cathode.

By energizing the plate with respect to the cathode with a potential of about 90 volts direct current it is possible to direct most of the electrons emitted by the cathode to the plate to achieve the greatest efficiency. Thus, as the varying light waves from the film are directed at the cathode of the photo-electric cell, an alternating current which is directly proportional to the light waves is superimposed upon the exciting direct current. This electric current is very minute and is of the same order as that created by the microphone.

Before converting it to sound waves

it is necessary to amplify the electrical waves to a useful intensity which will properly actuate a loudspeaker. The electrical waves are, therefore, directed to an amplifier where they are increased in amplitude until of sufficient intensity to operate a power amplifier. Power amplifiers of various outputs are made available for different size theatres. These vary from 5 to 150 watts in capacity, and the tendency recently has been toward increased power due to reduced recording levels.

It is no doubt evident that the entire sound reproducing system should be of uniform efficiency over the entire range of frequencies and volume, which means that no distortion or change in the character of the light, electrical or sound waves can be tolerated. The amplifiers are operated from the alternating current power supply. Great care must be taken, however, to minimize any hum from this power source. Consideration must also be given to service and installation requirements in the design of the amplifiers.

Theatre amplifiers are designed for either wall mounting in cabinets or floor mounting on channel iron racks. A volume control is located on the amplifier panel so that the volume of sound from the stage loudspeaker may be easily controlled within the desired limits. In this connection, it is also desirable to locate some sort of a volume control at each projector so that a uniform level may be maintained, by presetting after the first show in changing from one film to another where the recording levels vary.

In some cases, a small amplifier is placed at each projector to permit this control without loss to the intensity of the electric waves. Provision is made to balance the output of the photo-electric cells in each soundhead attachment by varying the exciting voltage.

There are some instances where either the acoustic condition of the theatre or the quality of the recording on the film make it desirable to decrease the ampli-

fication of certain of the frequencies. Controls for so doing by means of filters are provided.

It has been found that the use of alternating current on the exciter lamp in the soundhead limits the possible satisfactory amplification of the lower frequencies due to the hum introduced by the alternating lighting of the lamp filament causing the photo-electric cell to create an objectionable current of the same frequency as the power source. Except on the least expensive system for the smallest theatres, a rectifier unit to convert the alternating current to suitable direct current, which will not cause any hum, is provided.

For sound changeover the current is generally switched from the exciter lamp in one soundhead to that in the other. In some cases the input of the amplifier is also switched from one photo-electric cell to the other simultaneously.

● Loudspeaker Action

The greatly amplified electrical waves are then directed to the stage loudspeakers behind the screen where they are converted into directly proportional sound waves which are presumably the same sound waves originally created in the recording studio. The horn loudspeaker has been found to be particularly suitable for theatre reproduction because of the combination of high efficiency and the possibility of any directional pattern desired.

The best combination of loudspeakers now employed consists of a multi-cellular horn driven by electro-dynamic speakers of the diaphram type for the higher frequencies between 300-400 and 10,000 cycles per second, and of a folded directional baffle horn driven by electro-dynamic speakers of the cone type for the lower frequencies from 40 to 300-400 cycles per second. The major problem, however, has been to design a loudspeaker system with sufficiently high power handling capacity, uniform response over the broad range of frequencies, and uniform directional characteristics.

To accomplish the first two objectives the solution has been the use of two separate loudspeakers as indicated, one designed especially for the higher band of frequencies and the other for the lower frequencies with practically no overlap. The latter problem has been one of the most difficult. As the frequency of the sound waves increase and the wavelength decreases, the angle of dispersion of sound waves from a loudspeaker decreases.

Thus we encounter two problems. The lower frequencies are distributed over such a broad angle that they must be carefully controlled to prevent too much reflection from walls or ceiling causing unsatisfactory results. On the other hand, the higher frequencies are distributed over such a narrow angle that it is difficult, particularly in wide theatres, to direct them at the entire seating area. The folded directional baffle with two or four speaker units, as the case may be, easily distributes the low frequencies over the entire seating area with high efficiency.

The multicellular horn for the higher frequencies consists of a series of individual horns, 9 to 18 in number, depending on the shape of the theatre, moulded into one horn all with a common source consisting of two speaker units. These individual horns are placed so that the outside ones have a distribution angle of from 70 to 120 degrees both horizontally and vertically. Thus each horn distributes the higher frequencies in its necessarily narrow beam, but, because of the multiplicity of small horns, the result is a broad uniform distribution of all the higher frequencies.

A monitor loudspeaker, often with its separate amplifier, is located in the projection room so that the projectionists may listen to the sound to check approximate quality and volume. In some cases, a control is placed on the back wall of the auditorium in a locked box so that a theatre employee may directly regulate the volume from the stage loudspeakers right in the auditorium where the direct sound can be heard.

Considering the sound system as a whole it must be recognized that refinement of the highest order is required in the design, manufacture and installation to make possible the high quality of sound reproduction demanded today. The electrical, optical and mechanical parts of the system are delicately fabricated and adjusted. It is remarkable that such a system can

be as easily operated over long periods of time with little effect on the quality of the reproduced sound as is accomplished in many of the theatres throughout the country.

● Strive For Realism

Broadly speaking, the objective towards which the engineers and scientists labor is to improve the quality of both the projected picture and the reproduced sound to the point where any impression of the process being mechanical is eliminated. In this program there are really two different phases.

The first involves realism. This means making the projected image look just as the actual image does to the eye. Before this is possible color of a quality so fine that, after the novelty has worn off, it is not even noticeable to the viewer, must be achieved. While great strides have been made in the perfection of color motion pictures, we still are some distance from this goal. In addition, depth or third dimension must be also added.

Considering that lenses with a single focal plane are used both in the camera and projector, that film of a single emulsion is used, and that a flat screen is employed, the possibility of accomplishing this is remote. Up to this time, the only possible solution lies in the direction of projecting double images with polarized light and requiring the viewer to wear polarized lens glasses so that each eye sees its own and proper image. Although this has by no means been perfected yet, one great limitation is that a viewer without glasses cannot enjoy the presentation. In any event, the perfection of color and stereoscopic pictures will carry us very much nearer the goal.

Realism also means a quality of sound in the theatre that is a mirror-like reflection of the original. The strides made in the last ten years cannot be overemphasized. Nevertheless, the great number of mechanical steps involved, in each of which distortion of one nature or another may occur, makes this difficult.

Experiments in stereophonic sound in which two or more separate channels are employed in both the recordings and reproducing process, so that realism is enhanced by improved space relationship of the sound source to the photographic image, have proved that in the near future further strides will be made in this direction. It is further conceivable that in the future separate channels, one for speech and one for music, may be successfully employed with different power handling capacities and different loudspeaker locations to better achieve realism.

The other phase of the broad program involves the problems that are more difficult to physically recognize. Even if all of the objectives so far mentioned are achieved, they are not of greatest value if the theatre patron must be subjected to undue eye or ear strain in order to enjoy the sound motion picture. If the motion picture in the theatre is for entertainment purposes, then the thousands and sometimes millions of dollars invested in the production of the picture must not be sacrificed in any way by subjecting the patron to a physical strain to get the entertainment for which he has paid and deserves.

Elimination of undue eye and ear strain is a complex problem. Briefly, the amount of projected light on the screen due to the projection lamp employed; distortion to the projected image due to either the projector or the viewer being at too great an angle with that vertical to the screen; the rapid contrasts of dark images and those with plenty of light, due to the makeup of both a picture and show; shutter flicker; travel-ghost which is the distortion resulting from improper relationship of the shutter and the intermittent movement; film motion due to improperly designed or adjusted projector; glare due to improper screen; reflections from auditorium surfaces adjoining the screen; amount of light in auditorium; projection through smoke or dirty projection room port glass—all these contribute to eye strain.

Ear strain is caused by reproduced sound in every seat of insufficiently realistic quality or of insufficient intensity. Too many people come out of too many theatres today with headaches as a result of such physical strains. These factors are more difficult to eliminate commercially because they are not so easily recognized.

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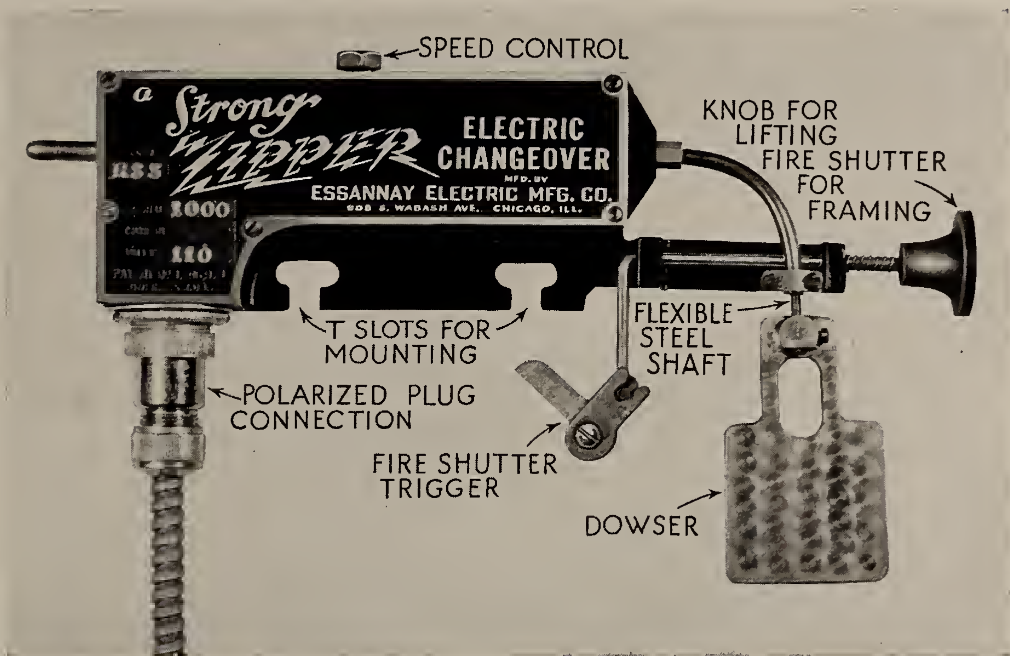

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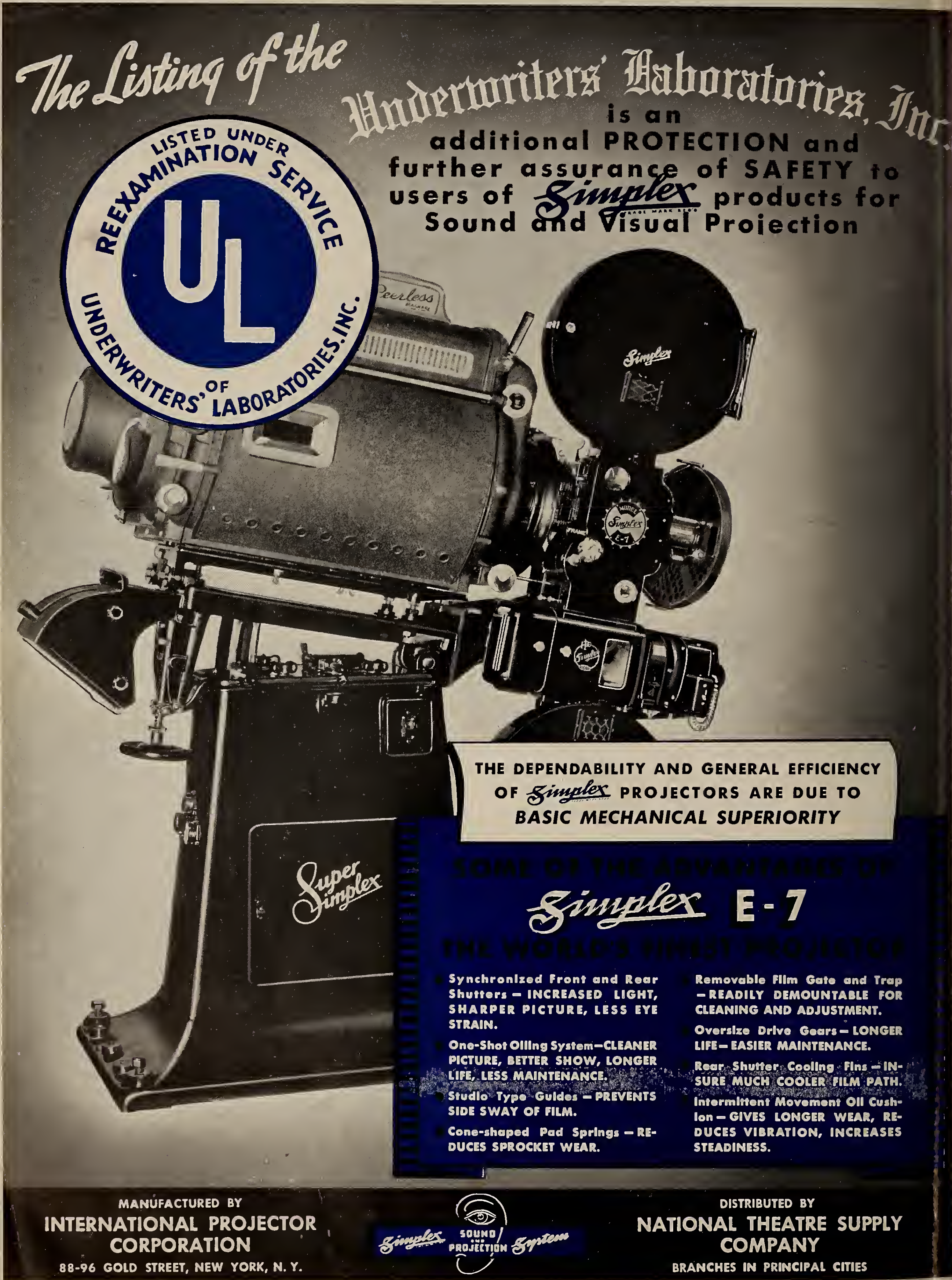

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Monthly Chat

IMPORTANT changes are taking place in the projection field but so subtly that practically nobody has paid particular attention to them. One such, previously mentioned herein, is the ever-expanding use of 16mm. equipment in small theatres and in one-night stand auditoriums. Manufacturers of such equipment, probably fearful of exciting Labor's interest, are none too cooperative in supplying I. P. with details anent such units—although they must cross this bridge eventually.

The other change relates to the swarm of retail radiomen who are now doing almost all of the p. a. system work in theatres. We see this as definitely bad news for projectionists, which craft should be just as insistent about covering such jobs as they were about the interference in the past by outside sound picture servicemen. It doesn't take these radio fellers long to "graduate" from p. a. work to sound picture work—and they have the added advantage of always being on the spot "around the corner".

Of course, in order to do anything effective about this situation, projectionists must know something about p. a. apparatus. I. P. is ready to do its share, as is evidenced elsewhere herein.

- - -

Most exhibitors and some projectionists display a passion for repairing any and all equipment regardless of condition or age. This despite the fact that a repair bill often approximates forty per cent of the cost of a new unit; and that which the theatre has even after an extensive repair job is anybody's guess—declare us out. The replacement of an occasional part or parts, the overhauling of a projector head, *etc.*, reflects smart business sense—but not when the cost approaches any sizable proportion of the price of new equipment. Lean heavily on this angle when the boss next gets repair fever.

- - -

THAT which we promised for this issue—a plentitude of material, technical and otherwise, relating to television—we are unable to deliver. A couple of contributors fell down on the job (probably the holiday lethargy is to blame): but they promise to make good in ample time for the next issue. So be it. Anyhow, there's the possibility that somebody may "revolutionize" the art meanwhile.

- - -

The year 1938 can be marked down as one of the dullest ever from the standpoint of progress in projection equipment and technique. The coming year is rich in promise (so, too, was 1938), but we'll await tangible evidence of this before going overboard on predictions. Definitely promised, however, are vastly improved lamps and higher-quality optics. By the way, what happened to those "radically different" light sources and metal mirrors scheduled to bloom early in 1938?

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INTERNATIONAL PROJECTIONIST

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DECEMBER 1938

P. A. Units Increasingly Important in Daily Projection Routine

By *AARON NADELL*

Projectionists generally have displayed little interest in p.a. systems, even when, as is common, the unit is fed through the projection room amplifiers. Result: theatres are overrun with swarms of radio men "from around the corner" whose presence in theatres is neither necessary nor desirable from a craft viewpoint. To stimulate interest in this important aspect of craft activity, I. P. will publish a series of articles, of which this is the first, relative to all phases of voice reinforcement.

IN MANY theatres microphones for stage sound reinforcement operate through the sound picture amplifiers, which consequently do double duty as public address amplifiers. Wherever this is the case the projectionist necessarily carries some degree of responsibility for the p.a. results. Amplifier trouble can spoil the p.a. sound, of course. Of more direct importance is the fact that trouble elsewhere in the p.a. system may damage the amplifiers and thus spoil the picture show.

In larger theatres the p.a. equipment is under the control of a stagehand or a special p.a. operator. These men and the projectionist must cooperate not only in finding trouble but in routine precautions to prevent it. At times they may share responsibility for a single piece of apparatus: for example, the switching panel that changes over the amplifier from one function to the other, or a sound rectifier that may supply power for both projection and p.a. uses.

In smaller theatres p.a. as well as ordinary sound is under the sole control of the projection staff. This may be true even where the p.a. system is an entirely separate unit.

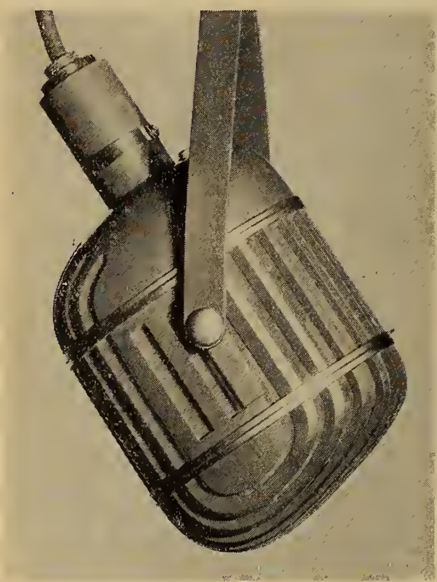
In some of the larger houses the p.a. system is also a wholly separate unit, separately operated, and the projectionist has no direct connecton with it. In most such theatres he still retains an indirect connection. In times of trouble the p.a. men borrow his meters and spare parts. As one of the few men about the theatre familiar with sound apparatus, he sometimes lends his help and advice in times of emergency—very unofficially, of course. Unofficially, the situation is occasionally reversed when the projection room has trouble.

For quite a few years after sound pictures were introduced p.a. was a matter of small concern to most exhibitors, but today a strong trend toward some degree of stage entertainment, coupled with the prevalence of theatre prize-givings, *etc.*, has lifted the microphone to greatly increased importance. Managers who never had microphone facilities, and the much larger number that had them but never bothered to use them, now recognize the importance of speech reinforcement equipment. Some projectionists have kept themselves up to date on p.a. equipment, but the majority, it seems, have not.

The basic nature of public address apparatus, and some of the ways in which it differs from the more familiar sound

picture equipment, will be described herein.

In p.a. equipment the photo-electric cell, as a source of sound current, is replaced by other devices, of which the microphone is the most common. In theatre work, microphones are located on or about the stage. A floor stand



W. E. 639A CARDIOID MIKE

The very latest Bell development is a "natural" for p.a. work, because of its directional characteristic

downstage center is the simplest arrangement, but its usefulness is limited. Some theatres use a trap-door arrangement by which the centrally-located mike stand can be made to appear or vanish as desired. Otherwise a long cable may be used and the instrument carried offstage and on to suit different occasions.

● Multiple 'Mike' Set-up

The central microphone and stand is very often supplemented or replaced by a string of microphones concealed among the footlights. These may be spaced, roughly, about ten feet apart, the total number used depending on the stage width. Additional microphones may be concealed in the draperies overhead, in the wings, or both. The same microphone is not always suited to close pickup and distance pickup; when those instruments are bought the manufacturer or supplier should be advised of the way they will be used and asked to ship a suitable variation of the model chosen.

Some microphones are of very high impedance and need coaxial cables of the type used for photo-cell connections in some sound systems. A long run of such cable greatly increases the noise pickup. Where microphones of such nature are to be coupled to the projection amplifier—or any other amplifier located at a distance—pre-amplifiers are often used backstage. These provide a low-impedance output, whch can then be run satisfactorily over any necessary distance.

Some microphones have low output impedance. They need no pre-amplifiers, but present a different problem when the p.a. system is located beside the stage switchboard and the projection amplifier is not used. Common practice would wire a low-impedance microphone to an amplifier through an input transformer of low primary impedance. In the circumstances mentioned, this practice often leads to trouble. The amplifier input transformer, even though very well shielded, picks up noise from the heavy currents of the stage switchboard. In such cases it is found practicable to eliminate the transformer, coupling the low-impedance microphone line directly to the high-impedance tube input. The input tube is operated in Class A and its grid draws no current.

Microphones concealed in the footlights or otherwise operated for more or less distant pickup present a very serious problem (not experienced in sound picture work) in that they must not respond to sound from their own loudspeakers. If the amplified sound from the speakers re-enters the microphones with greater volume than the original sound, the entire system is feeding back, and the result will usually be squealing, sometimes motorboating. The pitch of the sound will be of that frequency which re-enters the microphones at greatest volume.

To overcome this trouble and still provide enough amplification to supply the audience satisfactorily is a serious problem. Every part of the system must contribute to its solution. As far as the microphones are concerned, help is sometimes derived from the fact that directional microphones are available: these can be so pointed that they will respond strongly to sound originating on the stage, but only weakly, if at all, to sound originating at the loudspeaker locations.

Even more important is that the microphone response be "flat". If the instrument "peaks" at any frequency, feedback at that frequency may occur while the other tones still are too weak to provide the audience with satisfactory volume. With a "flat" microphone the overall volume can be raised with less danger that any single frequency will be reproduced loudly enough to feed back.

● Modern P. A. Microphones

Modern microphones differ in construction and in principle of operation. The old carbon mike and the condenser mike are essentially passé. A modern variation of the condenser mike, called the "condenser-velocity", enjoys a limited use. The most common types are the crystal, the dynamic and the velocity.

In the first of these, a Rochelle salt crystal, (or crystals) vibrates either in direct response to sound waves or because it is coupled mechanically to a small diaphragm. Such a crystal, properly mounted, delivers alternating voltage with very small current when mechanical vibration is forced upon it. Its impedance is very high; electrically it may be considered a condenser. Some of these units are mounted in cases so shaped, or equipped with shutters, as to make them directional.

The construction of the dynamic microphone resembles that of a miniature permanent-magnet dynamic speaker. In the speaker, an alternating current passed through the voice coil causes the diaphragm attached to that coil to vibrate; in the microphone air waves vibrate the diaphragm and an alternating voltage is generated in the coil. The difference is the difference between motor and generator, and like motor and generator, speaker and dynamic microphone can be made to complement each other's functions.

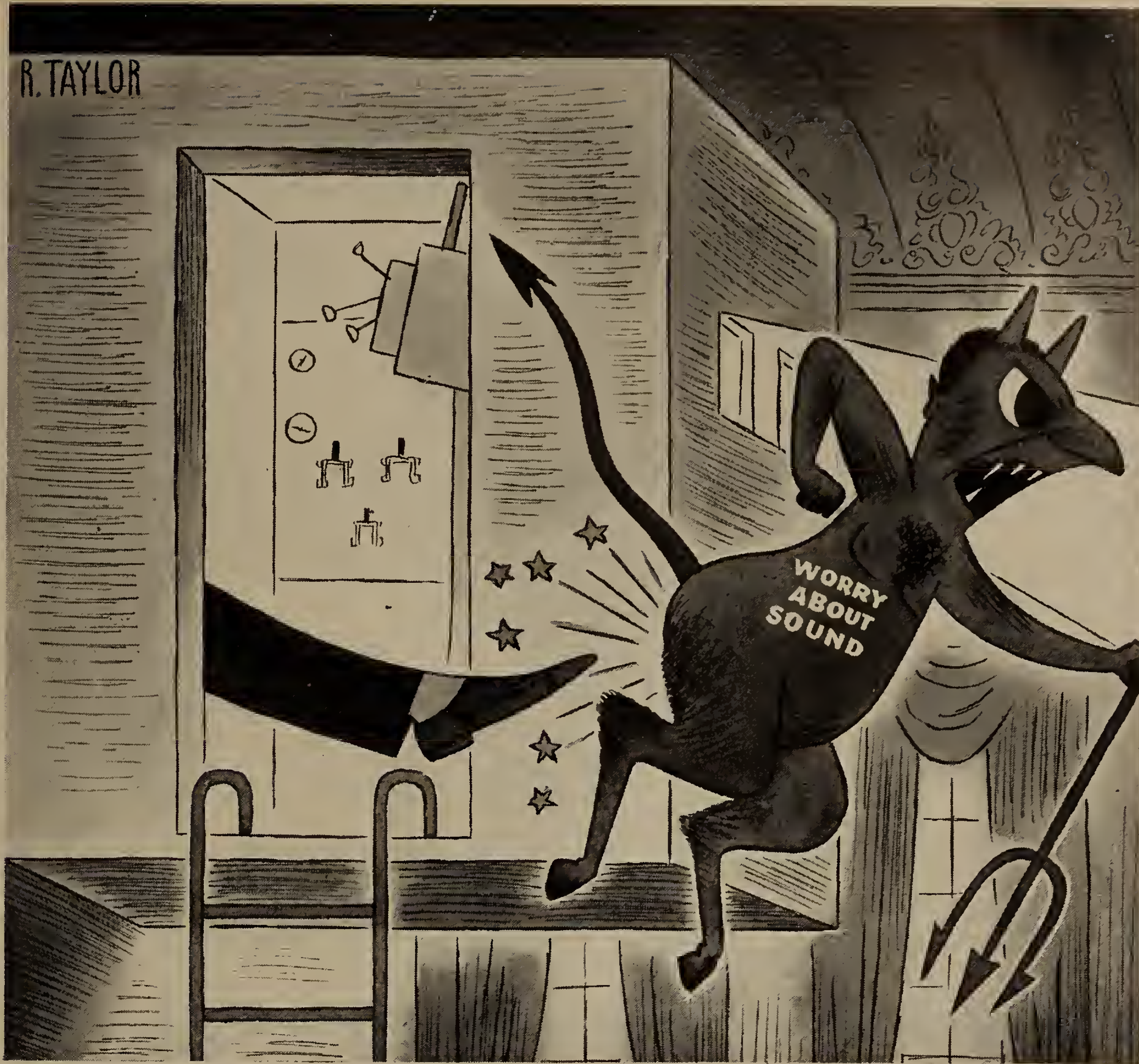
In an emergency, a small permanent magnet speaker can be substituted not too unsatisfactorily for a dynamic microphone. (A larger speaker will do the same thing if the sound is loud enough to cause its heavy diaphragm to move). The microphone could theoretically serve as a speaker, or as a headphone, but is not built heavily enough to handle appreciable amounts of power.

The velocity microphone is a special

Amplifier Corp. of America

Popular p.a. amplifier. Note 6-position mixer by which output of 6 sound sources can be blended

variation of the dynamic unit. There is a permanent magnetic field, usually provided by a pair of horseshoe magnets, and in that field a corrugated ribbon of extremely thin metal. Duralumin is favored. Sound waves cause the ribbon to


R. TAYLOR
WORRY ABOUT SOUND

flutter or vibrate, and in consequence a current is generated in it.

Dynamic microphones are provided with voice coils of moderately low impedance, which may or may not be varied by a transformer built into the casing. The dynamic casing takes different forms according to the nature of the directional, or non-directional, response desired. The velocity microphone has normally an extremely low impedance, that of a few inches of thin metal ribbon, with a built-in transformer to give it a working output of a few ohms, a few hundred or a few thousand ohms. The velocity microphone is inherently directional, since sound striking the thin edge of the ribbon has no effect on it; but by tilting it horizontally or semi-horizontally the directional effect is minimized and satisfactory pick-up can be obtained from any location.

Baby microphones of these types are available as "lapel" units to be worn about the clothing of the performer or speaker. They give more even response as the speaker moves about, hence avoiding occasions of too little volume and opposite occasions of volume peaks that may cause feedback. However, they require the user to trail a thin cable.

Contact microphones are a special form of miniature microphone, of any of the types mentioned, that are designed for direct connection to a musical instrument. They are fastened in various ways, including suction; but the most popular method at present is the use of thin adhesive tape. They respond to vibrations with which they are in physical contact but not to sound waves in air, hence they do not cause feedback. They lend a valuable reinforcement to certain instruments of a band or orchestra and to instrumental solos.

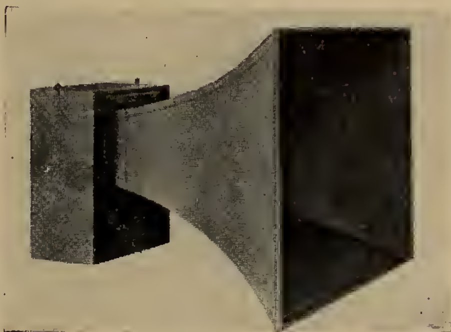
● P. A. Input Circuits

Theatre p.a. systems also use phonograph turntables as sound sources and very often are equipped to mix phonograph sound and microphone pick-up. Modern phonograph reproducers may be of crystal type, fundamentally similar to to the crystal microphone, and as such essentially condensers that cannot be tested with an ohmmeter. The more familiar magnetic reproducer is also widely used today. The records in most cases are of the common phonograph type, lateral cut, twelve inches in diameter and played at 78 r.p.m. Double turntables are often used, but the modern fader arrangement between them is not necessarily a changeover: it may permit both records to play simultaneously, each at whatever volume is desired, thus blending the music with special effects records.

Where the p.a. pickup operates through the sound picture amplifier a changeover switch may cut out the photocells and cut in the p.a. source. If there is more than one p.a. source, a mixer replaces or precedes the changeover switch. The mixer may consist of a number of potentiometers—more usually T pads or ladder pads—or it may consist of a number of amplifying tubes, each with its own volume control and all with their outputs connected in common.

● P.A. Mixer Controls

Where the p.a. system has its own amplifier, the mixer may be an integral part of it. Some sound picture amplifiers today include mixers which permit both changeover between projectors and provide facilities for mixing p.a. sound sources. In such equipments the demarkation of any projectionist's responsibility for p.a. becomes particularly hard to define.



Jensen Radio Co.

One type of directional baffle used for p.a. work, in which speaker is entirely enclosed, eliminating backwave. Enclosure is specially designed to prevent distortion

The p.a. mixer controls are sometimes located outside the projection room entirely, calling for a special operator to adjust them from time to time to give best results and to avoid feedback under all conditions. Where the p.a. mixer is part of the film sound amplifier, the projectionist may have to operate its control by watching and listening through his ports.

● P. A. Amplifiers

Mixer control circuits incorporated in an amplifier which also serves for film sound are complicated by provisions for the photocell voltage supply, which distinctly must *not* be fed to crystal, dynamic or velocity microphones. Remembering this detail may clarify the tracing of such circuits. To the contrary, if a condenser-velocity microphone is used, voltage supply is needed substantially identical with the supply to the photocell, and the input arrangement may perhaps be a simple changeover switch.

The p.a. amplifier is identical in principle with that used for sound pictures, but it may or may not have special modifications. Of these, the most prominent is some special input mixing arrangement.

In gain or amplification, the p.a. amplifier may go the picture amplifier one better, since some types of microphones have considerably lower output than the p.e. cell. Other types, however, and the phonograph pickup, have far higher output. The p.a. unit may therefore include pre-amplification ahead of the mixer for some inputs, and not for others.

In any given theatre the maximum p.a. output volume requred is roughly the same as the maximum sound picture output, thus amplifier wattage ratings are comparable.

Public address amplifiers often include provisions for automatic volume control, which sound pictures cannot use. The effect of such circuits is to boost weak volume and cut down peaks. The most common method is to tap off a portion of the sound current passing through the amplifier, rectify it, and use it to modify the grid bias of one of the amplifying tubes. The rectified sound current will be d.c. of a voltage varying according to the volume of the input at any given instant. The grid bias of the amplifying tube to which it is applied fluctuates accordingly; and when the input volume becomes too great, amplification is reduced; with low input volume amplification increases.

Automatic volume control, therefore, prevents peaks, originating in carelessness by the performer, which might cause feedback, and at the same time insures that sufficient sound volume will always be delivered to the audience, even if the performer turns his face away from the microphone. The arrangement is a great help to the control operator, and almost a necessity where no operator is used.

Automatic volume expansion is just the reverse of this arrangement, and may use the very same wiring, operating through a polarity-reversing switch to connect the modifying grid bias voltage in opposite polarity. The effect will be to increase amplification with strong input, and cut it down with weak input, thus adding to volume contrast. The attractiveness of phonograph record music is greatly increased by expansion, which, on the other hand, is not practical for use with microphones.

The p.a. amplifier, like the microphone, must have a very flat response characteristic and for the same reason—avoidance of peaks that might produce feedback.

Reverse feedback is used in p.a. amplifiers just as it is in picture amplifiers. This is entirely different from the type of

(*Continued on page* 29)

Studio Projection: Routine, Methods and Equipment

MERLE CHAMBERLIN

By *MERLE CHAMBERLIN*

CHIEF PROJECTIONIST, METRO-GOLDWYN-MAYER STUDIOS

STUDIO PROJECTION—two words with a very vague meaning to the majority of projectionists outside of Hollywood. This article gives my brother craftsmen a clearer conception of the actual meaning of the phrase "Studio Projection" and how it materially differs from, yet is very closely related to, theatre projection. To promote a clearer understanding of the paragraphs to follow we will start with a description of the general background of a studio projection department.

The M-G-M Studio Projection Dept. consists of a permanent crew of 54 projectionists. These men are responsible for the operation of 21 rooms, rear transparent screen projection, scoring stage, synchronizing stage, 8 Moviolas, portable equipment, *etc.* All projectionists are members of Hollywood I.A. Local 37 and all are former theatre men, the majority with Los Angeles projection licenses. The hours are necessarily different from those in a theatre because most studio work can be done to greater advantage under natural daylight conditions. A studio projectionist can be virtually assured of his evenings and Sundays off. The working conditions are naturally much more favorable.

Studio projectionists must have all the attributes of good theatre projectionists —and more. In these days of "efficiency experts" and "budgeteers," time is the most important item within the studio gates. Thus, in addition to the accuracy and efficiency constantly demanded in all branches of projection today, the studio projectionist must put equipment cleanliness and speed on a par with those other factors that promote the presentation of a good show. The inside of our projectors are painted white on the working side. This aids cleanliness and enables the projectionist to immediately detect any oil leakage or foreign matter that might be a detriment to the condition of the print that has gone through the machine.

As we follow the routine of studio projection, we will readily see how a scratch caused by an emulsion-caked roller or unnecessarily dirty film can cause a serious financial delay due to the necessity of waiting for reprints before work can be resumed on a picture. We will see also how a group of slow or inefficient projectionists could easily increase the cost of a production by a series of inaccurate operations.

To become familiar with the routine, we will take a scene directly from a script and follow it through the various stages of studio projection. The scene is one of the trick flying shots from "Test Pilot," the recent M-G-M picture.

● Preliminary Steps

When a scene is first definitely decided upon for a picture, there are a series of decisions to be made, all necessary for the proper execution of the shot. One of the first of these decisions, after the acting personnel has been decided upon, is the wardrobe and what are commonly termed "technical tests"—*i.e.*, tests that are photographed so that the director, along with his technical advisors, can decide on the proper wardrobe; also, in the case of a scene like the interior of an airplane, the technical correctness of the dashboard accessories, *etc.*, must be very thoroughly investigated.

These shots are projected before the actual production of the picture. For this type of projection, we have four review rooms. These rooms are 36 feet long by 15 feet wide, containing 12 seats, using a 7-foot picture projected by standard Simplex projectors, Ashcraft low-intensity lamps, and an Erpi 41 and 42 amplifier and Universal base with Erpi Type C dual-film or "dummy" attachment. The dummy attachment is shown in Fig. 1.

After these data have been assembled, the next move is to decide whether the shot can be more efficiently made by shooting it under actual flying conditions or done on the stage with photo-image or transparent screen projection. We will assume that the decision is made to make the shot on the stage. The shot is a flying effect, so that will naturally entail clouds moving vertically or horizontally, as the action may determine.

The next move is the selection of the proper background to be projected in back of the airplane on the stage. For this purpose we have one review room, also 36 feet long by 15 wide, containing 12 seats, using an 8-foot picture projected by Powers projectors, Ashcraft low-intensity lamps, with a special M-G-M sound system adapted to the Powers 6B base with a mechanical interlock between the two projectors. We use Powers projectors for this purpose because the film used for this type of projection cannot be waxed, as is explained subsequently.

The reason for the mechanical interlock is that in cases where there is any doubt as to what the completed shot is going to look like, the foreground subject can be photographed, then projected on one machine with the background on the other machine at a reduced amperage, thereby giving a semi-double exposure effect, but still giving a very good idea of what the completed shot is going to be.

● Transparency Projection

The background decision has been made, so the background is sent to the stage to be projected by one of our transparency screen projectors. This section of the department represents a very large investment in equipment. Only the very best projection will suffice, thus these stages have the very best equipment. The process projector, as it is called, consists of a Super Simplex mechanism with Geneva movement and intermittent sprocket removed, in place of which is

All Photos by
ERIC CARPENTER
METRO-GOLDWYN-MAYER STILL DEPT.

adapted a Bell and Howell pilot-pin camera movement.

When running film through a B. & H. pilot-pin movement, a frame is taken by a pair of pins, one on each side, and pulled down in front of the aperture, moved back onto a pair of stationary or pilot pins and then held there by pressure from the leaves of the guiding part of the movement. The thickness between these leaves is one and one-half times the thickness of a piece of film, which is why this film is not projected if it has any foreign matter on it, such as wax. The base of the machine is an extremely steady panning and tilting base built in our own shop.

The projector mechanism is connected by an electrical interlock to the camera. The shutters of the camera and the projector are synchronized to within 3 degrees of the 360-degree circle, so that there is absolutely no danger of loss of synchronization between the opening time of either shutter. The whole synchronous electrical system is driven by a distributor supplied by our three-phase system obtainable on any one of our stages. This distributor is housed in a soundproof box on the stage and is operated by remote control by the projectionists.

The lamphouse is a Model A Brenkert adapted for a range of from 90 to 270 amperes. The baffle of the lamp is cooled for the higher amperages by water that has been circulated through the hollow back plate of the projector mechanism. This water is pumped from an automobile radiator bolted to the outside of the room, making a complete circulating unit independent of any outside water supply. This complete equipment is housed in a cage-like elevator operated by the projectionist. This elevator is so constructed that the entire unit can be raised or lowered, thereby keeping the lens height on a level with the camera lens regardless of the angle required for the shot.

In addition to the projection equipment, each of these elevators (of which we have four) contains a lens box with a complete set of Cooke projection lenses in half-sizes from the 4-inch to the 8-inch. Each room also has a Bausch and Lomb 12-inch lens used when a very small picture is required. In addition to all this equipment, the projectors are adapted for reversible projection when needed, and we have various other accessories that have been developed for different types of shots as they came up during our schedules.

When the shots require a stationary background, we utilize a stereopticon projector, using the same type of lamps as on the process projector, with our slideholder completely immersed in water circulated by a pump from a tank in the base of the machine. This allows us to keep the slide on the screen for the entire length of a trim in the lamp, if that much time be needed for the cameraman to line up his set.

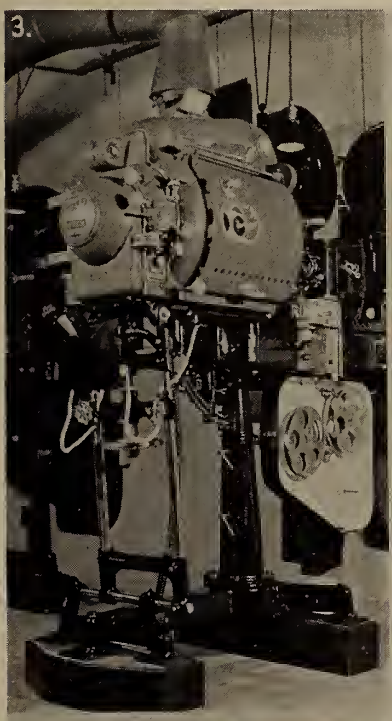
● Scene Studio Routing

When the scene has been completed on the stage, it is sent to the laboratory where it is developed and printed. Then the projection *really* starts. First, it is projected in the laboratory review room for the technicians concerned with density selection. The review rooms in the laboratory (of which there are two) are 35 feet long by 16 feet wide, having a 10-foot picture on a plaster screen (the plaster screen emphasizes any photographic defect) projected by variable-speed Powers projectors on a Powers 6B base. The reason for the variable speed is that when the lot is very busy we sometimes have as much as 60,000 feet of film to project and approve or reject during one screening. The average amount of rushes daily is 45,000 feet.

The scene is then matched to its sound track and sent up to the Sound Dept. for approval. The review rooms for the selection of the sound are 60 feet long by 30 feet wide, having a 12-foot picture projected by Super Simplex Projectors on Type M Simplex bases with an Erpi 86 Amplifier, the Erpi Type 1046 rear-scanning sound heads, and Erpi three-spindle dummies. In addition to the projection setup in this room, we have an auxiliary lens on one projector which can be moved into place, giving the sound inspector a 15-foot picture, thereby enabling him to more easily check synchronization on scenes about which he may be in doubt.

After the scene has been approved by the Sound Dept. it is sent to the film editor or cutter. He looks at it in one of our review rooms so that he can familiarize himself with all the peculiarities of the various takes before looking at them later with the producer or director. He uses one of our review rooms situated near the Cutting Dept. These rooms are 46 feet long by 20 feet wide, using a 10-foot picture projected by Simplex Projectors on Universal bases, using an Erpi 46C amplifier and attendant sound setup.

After the editor familiarizes himself with the film, he calls the producer and informs him that the takes are ready for his selection. The scene is then sent over to the Administration Building where we have six review rooms 51 feet long by 28 feet wide, containing 11 seats with a 10½-foot picture projected by Super



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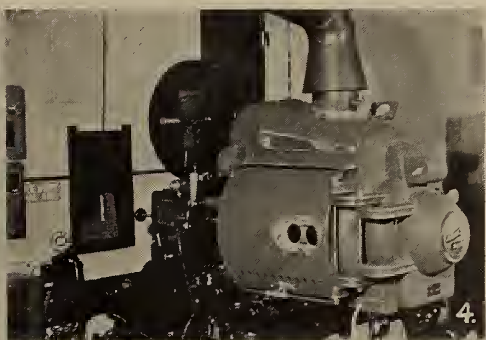

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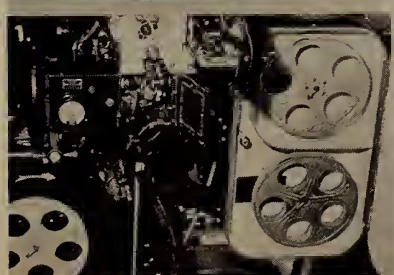

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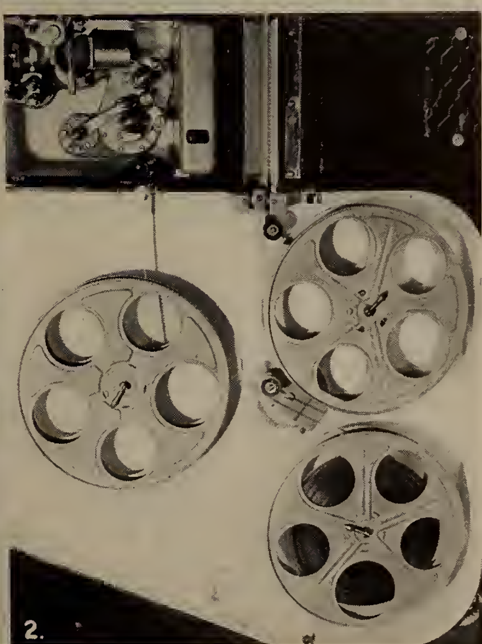


2.

Simplex Projectors with 5-point stabilized bases, using Erpi Type 1046 rear-scanning sound heads and type 1051 dummies (the new 3-spindle dummy shown in Fig. 2) an Erpi 86 amplifier and 85 current supply unit. The lamps in these rooms are Ashcraft Model D Suprex, current being supplied by a 50/50 Roth Actodector for each room.

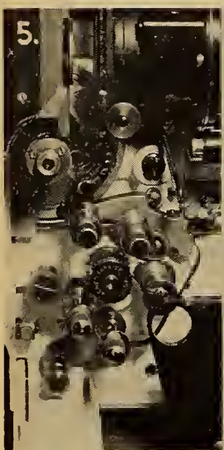
● Studio Review Rooms

Two views of these rooms are shown in Figs. 3 and 4. Opened for operation on August 20, 1938, they are the newest review rooms, (or projection rooms, for that matter) in Southern California. Each room is 18 feet long by 12 feet wide. The walls are asbestos acoustic Celotex treated for sound absorption. They are painted overall in a flat battleship gray. The portholes are single glass for the projection ports and double glass in the observation ports, both removable for cleaning.

The mechanisms are Super Simplex, adapted in our shop to our specific requirements. Fig. 5 shows the additional idlers necessarily installed around the take-up sprocket of the mechanisms so we can use that sprocket for both taking up the picture and feeding the sound track to the sound head as per the threaded-up sound head and dummy shown in Fig 2. The 5-point stabilized bases (Figs. 3 and 4) are mounted on spacing blocks, which are 3 inches of wood and 2 inches of cork. The raising of the machines was necessary due to the third, or sound track, spindle of the Erpi dummy being much lower than a regular take-up magazine. This enables the projectionist to thread the machine without having to get down on his knees.

The lamphouses (Ashcraft Model D) are supplied by the Roth 50/50 Actodector (one for each room, as shown in Fig. 6) controlled by a generator panel located at the right of the room amplifier. This arc supply setup gives us absolute control of the amperage and voltage at each lamp, because the voltmeter on the panel is hooked across the arc. In this Actodector setup any variation of voltage gives a corresponding change of amperage.

Each room contains a 6-foot rewind bench with a hand rewind, electric rewinds, and a B. & H. synchronizer. Each room has storage space for twenty 2000-foot reels and one hundred 1000-foot reels. The floors are cement with a sheet of copper, on top of which is one-half inch of felt, over which is laid a very heavy grade of linoleum. The copper prevents the linoleum from warping in damp weather.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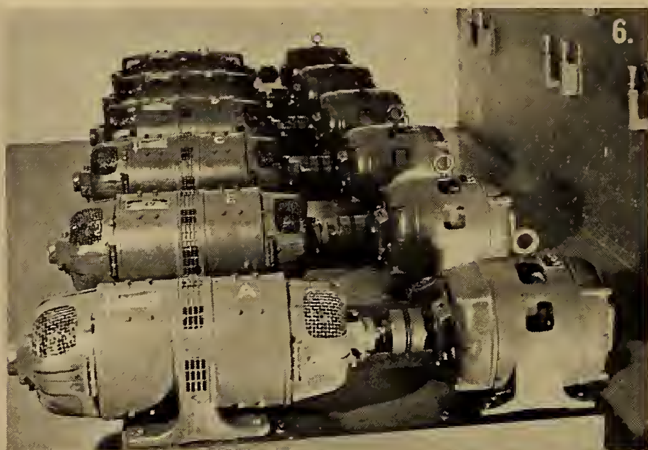
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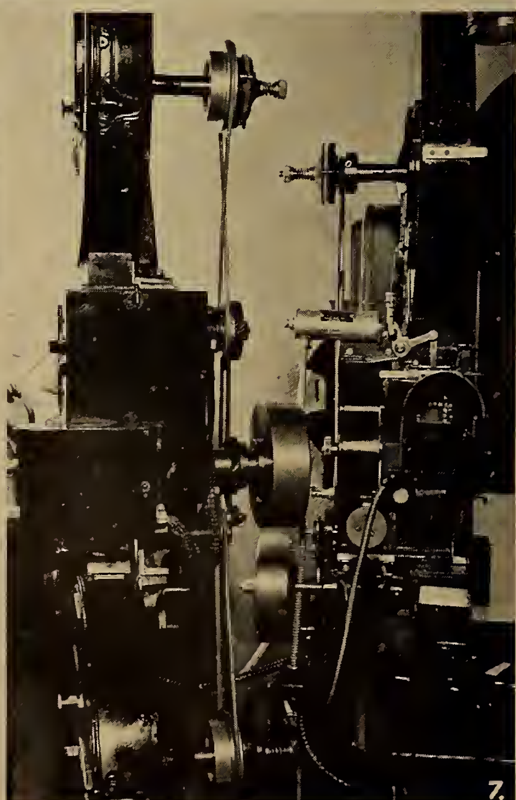

7.

Note the water-heater type of ventilation pipes on top of the lamphouses: an exhaust pipe is fanned out one inch larger in diameter than the pipe on top of the lamphouse, which tends to keep the lamp itself much cooler by drawing the heat from the top of the lamp, resulting in a cooler room while operating. These rooms are all air-conditioned. The foregoing gives a pretty good idea of the characteristics of these six rooms, of which I am naturally very proud.

After our scene has been approved by the producer, it is returned to the Cutting Dept. to await the finish of the current day's shooting, so that the director may look at his previous day's work. The director, followed by his assistant and the sound and camera crews, leave the set at the completion of the day's shooting and proceed to a review room to look over the previous day's work. These rooms are 55 feet long by 30 feet wide, contain 40 seats, have an 11-foot picture projected by Super-Simplex projectors and Ashcraft Model E Lamps on a Universal bases with an Erpi 41, 42 and 43 amplifier and Type C dummies. Fig. 1 shows this setup, including the dummy.

● The Scoring of Music

We will assume that there is to be musical scoring with this specific scene. So, after the laboratory, the sound department, the producer and director have approved the scene, it is sent to the music department for scoring. They take the film to a review room where we have a reversible projector (Fig. 7), a Simplex on a 5-point stabilized base with an auxiliary dummy, both driven by a d.c. motor adapted so that with the flip of a switch it will run backwards. To take this picture, it was necessary to remove the lamphouse, as I wanted to

show the one-way reversible clutches on the upper magazines and take-ups of both projector and dummy.

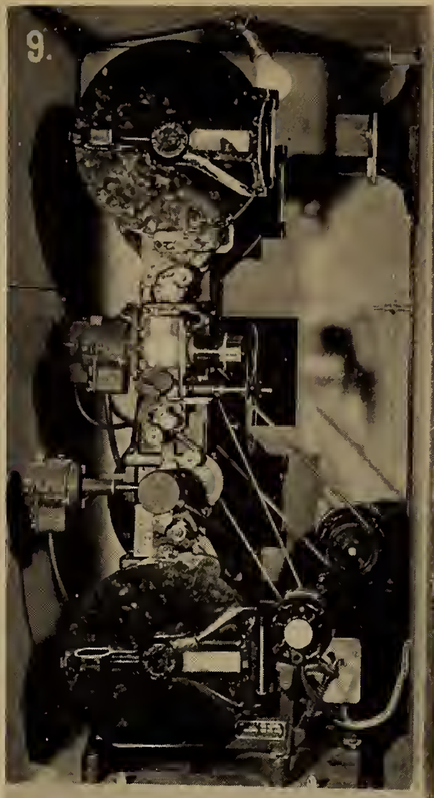
This machine runs backward as well as forward at 90 feet per minute. The only alteration we made to the heads was to extend the rails in the projector and build up the lower part of the gate so that the film would not double up between the bottom of the back plate and the intermittent sprocket when being pushed back up through the gate. The reason for the reversing of these machines is to save rewinding when the scorer is timing or synchronizing a short scene. If he happens to miss the cue, all he does is buzz once to stop, then three times to reverse the machine and return to the original starting mark.

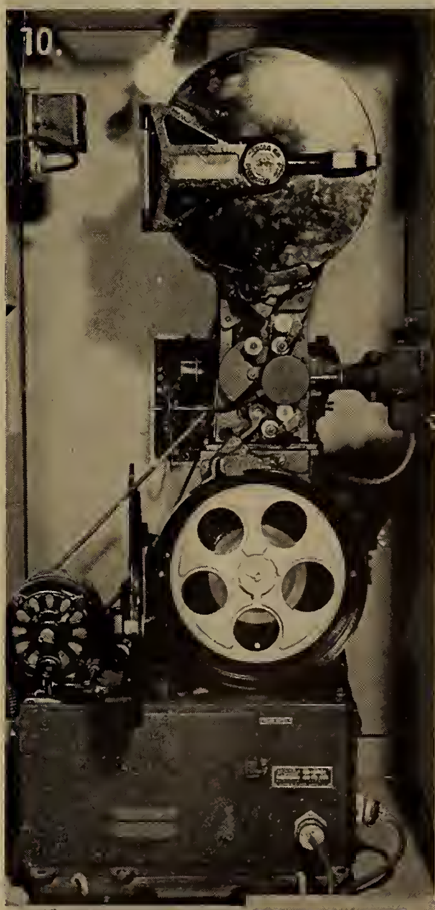
After the timing and musical synchronization has been decided upon, the film is then sent to the scoring stage. On this stage is a permanent room wherein is one projector synchronized electrically to the recording room. The picture is projected onto a screen seen by the director of the orchestra who, in turn, directs his musicians according to cues placed on the film.

We will also assume that there is some sort of incidental sound necessary for this particular scene that was impossible to record at the time of shooting. This requires the synchronization of sound effects. Assume that the noise required is that of an airplane starter button. The scene is then sent to the sound department for sound effect synchronization. They will take this scene and make it into a loop. This loop is sent over to the synchronizing stage and threaded in the projector shown in Fig. 8, a Simplex electrically interlocked to the recording machine. On the stage in front of the screen will be sound-effect men with an airplane starter or something that will sound very much like one. This loop is projected, and every time the pilot presses his finger on the starter button, the effect-men on the stage will run their starter. In that manner they can secure several takes in synchronization with the picture without losing the time of re-threading or rewinding.

● The Re-Recording Process

We now have the original dialogue track, the music track and the sound-effect track. These three tracks, along with our scene, are sent to the re-recording or dubbing rooms. The tracks are placed on three separate dummies electrically interlocked with a Simplex projecting a picture onto a screen in view of the mixer who is sitting at a desk with a series of potentiometers, one for each track, enabling him to control the volume of each track. After two or three re-





hearsals, a take is then made, placing the three tracks in their proper relation as to volume onto one re-recorded track. Several takes will be made, which in turn will be selected the following day in one of the sound department review rooms, much the same as the room used for the selection of this same scene when it was fresh from the laboratory.

These completed sound scenes are then cut into the reel and the picture is ready for preview. We preview in many theatres in Southern California, showing our product to portions of the public before it is actually finished, to get audience reaction on different scenes and different situations. The majority of these preview theatres are equipped with dummies enabling them to run the separate track and picture as we do in the studio. Those not so equipped are supplied with a pair of our own dummies kept for that purpose. One of our projectionists goes with the picture on each preview, helping as much as possible on changeovers, *etc.* Our men are of very definite help to the theatre projectionists because they are familiar with the picture, having projected it several times at the studio during the process of completing each reel. Our projectionist also takes with him a remote-control fader, which is installed in the auditorium of the theatre and is operated by an additional projectionist of the theatre staff who gets his instructions from the mixer who completed the reel in the re-recording.

These previews are attended by the producer, his assistants, the director, the laboratory and sound crews, and the film editor. The studio personnel in a theatre at a preview generally number about 50. The morning following the preview they get together and decide whether there should be changes made in the editing, or additional scenes shot, or if additional angles are needed of scenes already in the picture. They look at the picture in one or more of our review rooms.

We will assume that additional close-ups of our particular scene are necessary, so shooting is resumed. To enable the cameraman and the mixer on the picture better to match their previous work, we send to the stage what is termed a projection Moviola (Fig. 9 shows the picture side; Fig. 10 shows the sound-track side.) This machine has a reversible motor, is plugged in on the stage, and the film of any specific scene can be shown to anyone on the set at any time or as many times as necessary, thereby enabling the director to match his action, the cameraman his lighting, and the mixer his dialogue without running back and forth to a projection room or trusting to his memory.

With all the required scenes in the picture completed, the film is sent to the laboratory for a Movietone "answer print," which is the first print of the completed product. When this print is

completed, it is taken to a review room to be looked at by sound department and laboratory technicians for final corrections in density and sound level. This room is 60 feet long by 30 feet wide, with 33 seats, using an 11-foot picture projected by Super Simplex Projectors, Ashcraft Model E Suprex lamphouses, on Simplex Type M bases, RCA PS24 soundheads, using an Erpi 59B amplifier. The Sound Department makes its recommendations anent desired changes in sound level, the laboratory decides on any changes in density for specific scenes, after which the print is returned to the laboratory for correction. This process is repeated at least twice until every one is satisfied as to the photographic and sound quality of the print.

● Release Print Lubrication

When the print is finally approved, the release printing of the picture is started. As each print completes the routine of printing and developing, it is *projected* and *inspected*. Then it is placed on the waxing machine (Fig. 11) better known as a Film Lubricator, which was designed for M-G-M by J. M. Nickolaus the head of our laboratory[1].

This machine is rapidly replacing the old-type wax or processing machine. The emulsion does not at any time touch any part of the machine. In this machine is used a very light, high grade penetrating oil (Pyroil-Grade B), mixed with a very light wax base which is impregnated with the celluloid. Most important, it is impossible for any one reel or any part thereof to get more or less lubrication than the other part.

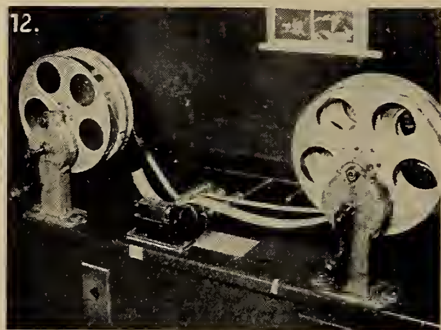
We will assume that the producer would like to take one last look at his picture and, at the same time, show it to a few of his friends at home. When this is the case, one of our projectionists takes our portables to the producer's home and runs the show (Zeniths with Operadio sound system). The interior of our portables is also painted white for cleanliness and efficiency.

In addition to the equipment described previously, our projectors utilize several items and innovations that might be of interest. All machines are equipped with a take-up nut which is a two-way nut working on the eccentric principle, *i. e.* turning the nut to the low side of the eccentric is the equivalent of three turns on the take-up spindle which are necessary for the efficient take-up of 2000-foot reels; backing it off the three turns or moving the eccentric to the high side enables us to take-up our 1000-foot reels with less danger of damaging the sound track. This was necessary at M-G-M because we use the 17½-mm. sound track.

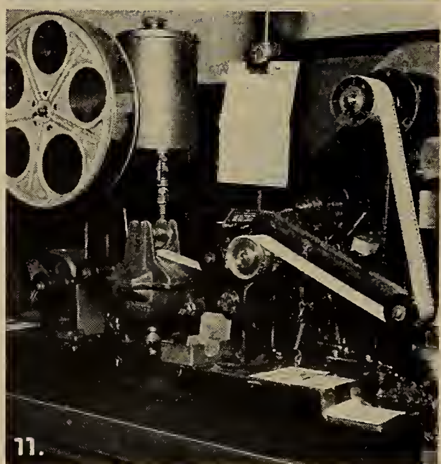
[1]See "M.G.M. Film Lubrication Policy," I. P. for June, 1938, p. 14.

Sound is recorded on both sides of the negative and then split in the laboratory, for obvious economical reasons (Fig. 12).

Naturally, in a studio projection room, with our short throw and proportionately small picture, we are faced with the problem of too much light. So, we use a graduated mesh screen in the front of our lamphouses, thereby cutting down our illumination without impairing the quality of our light (which a reduced amperage would do) or without inducing poor definition as a result of an abnormally small stop in the lens.



12.



11.

All of our work lights over the machines, as well as those over the benches, are counterbalanced so that the projectionist may use them at that height which best suits the work he is doing.

As we followed our scene through all the various stages of projection it encounters on the lot, we can readily see the opportunity that is presented for scratching the print or getting it dirty. Our standing instructions are that each print must reach a preview clean and free from scratches. The preceding paragraphs and the photographs of the equipment speak for themselves as to the advisability of keeping equipment in first-class condition.

I trust that the foregoing has conveyed a better understanding of studio projection as it affects the individual projectionist. I will be glad to answer any questions addressed to me at Metro-Goldwyn-Mayer Studios, Culver City, California, or through the pages of I. P.

VARYING CONCEPT OF SIZE

THE concept of size is an arbitrary one which varies with each individual. A foot-rule is a foot long, but the apparent size of a foot is open to great differences according to the interocular distance between the eyes. The greater the distance between the eyes the smaller is the apparent size of objects, for the reason that there is greater stereoscopic relief, the binocular vision seeing further around each object.

The size therefore of any object as viewed by different persons varies in accordance with this interocular separation. The greater the stereoscopic relief the smaller the apparent size; and this distance increasing with the growth of the individual from childhood up, nothing is more common when visiting a place not seen since childhood than to notice how much smaller such place appears.

Years ago, being then much interested in this question, I took three stereoscopic pairs from the top of a hill. The first pair were separated about three inches, which is the normal distance between the average eyes. The next pair were separated twenty yards between the plates, while the third pair were separated a hundred yards. Thus the latter view would be as seen by a giant with eyes a hundred yards apart.

Placed in the stereoscope the results were of great interest. The first pair gave me the view as I should see it. The second gave the impression of the view reduced to about the size of a room; but the third appeared as a beautiful little model in clay the size of the plate.

No one can see through any eyes but his own. Were he able to do so, and were the interocular distance slightly dissimilar to his own, he would at once become aware of a change in the size of the objects surrounding him, either larger or smaller according to whether the interocular distance were greater or less.

A monocular man sees, of course, no stereoscopic binocular relief. His objects are all in one plane: but mercifully his muscle of accommodation controlling the convexity of his lens becomes acutely sensitive, and by this means he is enabled in some part to recognize the distance between himself and other objects. Thus, with also a fine appreciation of parallax when he moves, he obtains a fair, but artificial, substitute for binocular vision, enabling him to register comparative distances; and it is wonderful how well he succeeds with years of practice.—Dr. E. A. Barton in *The Photographic Journal*, London, England.

NEW SMPE DUES SCALE

Effective Jan. 1, the S.M.P.E. dues will be \$15 for Fellows and for Active members, and \$7.50 for Associate members, instead of \$20, \$10 and \$6, respectively, as heretofore. Of these sums \$5 will be applied to the *Journal*. No admission fee is required for any grade.

Third Subscription Contest Diagram; Only 7 Winners on Previous Entry

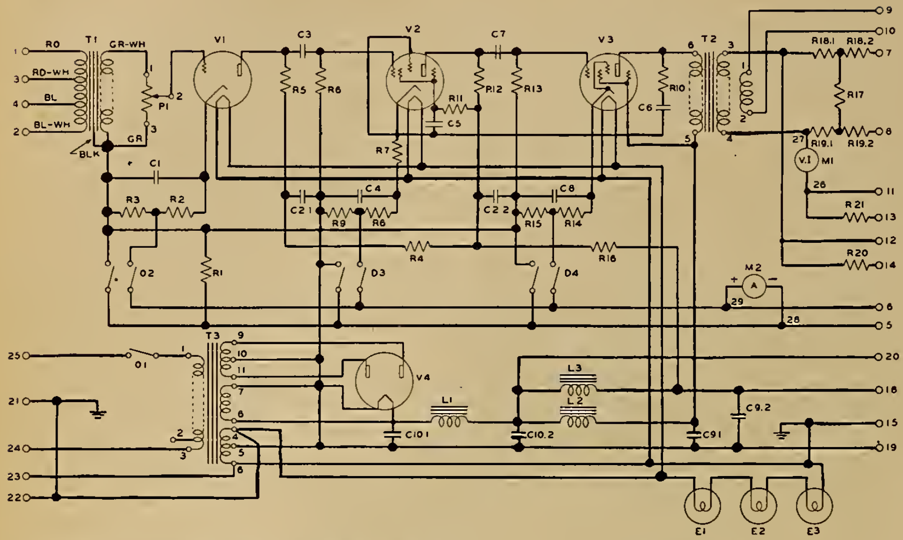


FIGURE 1

THIS month's Contest drawing, like its predecessor, reflects the desire of I. P. to afford an equal chance for all by presenting a circuit the checking of which for errors requires careful and intelligent effort rather than reference to any book, magazine or file; moreover, the chance that any contestant will be thoroughly familiar with this circuit through long use is remote (Fig. 1).

Once again we offer contestants several hints in tracking down the defects in the current circuit offering: there are *several* errors therein; many lines have been inked over, thus it is useless to try to detect the errors by means of uneven lines or any other indication of faulty draftsmanship; do not change any of the circuit constants, and all the errors are in the connections. With this lift, the job should not be too arduous.

● Advanced Deadline Set

As in the past, only subscribers to I. P. are eligible to compete. No consideration will be given to those answers which do not reach I. P. by January 18—a marked advance over previous deadlines. All those who submit the correct answers will receive a free one year's subscription to I. P. (The award will have to be changed soon if the old standbys continue their present fast pace.) It is not necessary to enclose a copy of the diagram, although this is elective on the part of contestants.

Last month's Contest diagram (Fig. 2) set the boys back on their heels, being so difficult as to challenge the ingenuity of the best craftsman. The errors therein are as follows:

● Errors in Previous Drawing

1. The center blade of the right-hand half of switch S-2 is grounded.
2. The top of R-23 does not make contact with Terminal 1 of Transformer T-4.
3. The 12-mfd condenser shown just right of R-24 should connect to the top of R-24 instead of to Terminal 1 of the interstage transformer.
4. The wire running from the double pole switch in the output circuit, which connects the blades of that switch to the top of T-6 secondary, should not extend to connect with the bottom of that winding also.
5. The plate of V-3 is open-circuited at the socket.

Some contestants were misled by the fact that the volume control is shown wired to the center tap of T-3 secondary, instead of to Terminal 4 of that secondary. Obviously the amplifier will work either way; it is shipped wired as shown, but R-11 can be connected to Terminal 4 in the projection room, if more gain is necessary. The open circuit at the top of E-1 was also deceptive, apparently. In this case also the amplifier is shipped as diagrammed, and the connection in question can be made locally if different frequency response is wanted to suit acoustic conditions.

● Allow Ample Latitude

Answers which included reference to these points were not disqualified unless the contestant definitely stated that the amplifier would not work with E-1 and the volume control wired as here shown.

Only seven contestants out of the scores who submitted answers were successful with last month's diagram. Here they are:

C. E. Mervine, Pottsville, Penna.; C. H. Perry, Sudbury, Ont., Canada; R. M. Hinshaw, Weiser, Idaho; F. C. Hartwick, San Francisco, Calif.; Elwyn N. Glynn, Cambridge, Mass.; R. E. Anderson, Local 468, Hickory, N. C., and George W. Hanlon, Darby, Penna. Congratulations!

LOCAL UNION ELECTIONS

Results of various projectionist Local Union Elections are as follows: 154, Seattle—H. Lampman, pres.; A. Evans, v.-p.; Jay Brown, rec. sec.; R. Cameron, fin. sec.; J. McNabb, b.a.; F. Myers, treas. P.A. Snider and D. Dvorak, members-at-large; trustees: W. Smith, F. Cook, and H. Clark.

Local 635, Winston-Salem, N. C.—H. Rogers, pres.; P. Peddycord, v.-p.; H. R. Faust, rec. sec.; J. Robertson, fin. sec.; O. L. Ziglar, b.a. and treas.; L. Craver, sgt.-at-arms; trustees: P. Peddycord and J. Keenan.

Local 253, Rochester, N. Y.—L. M. Townsend, pres.; L. E. Burton, fin. sec.; F. E. Boekhout, b. a.; L. M. Clark, v.p.; F. B. Spencer, rec. sec.; del. to Central Trades: F. E. Boekhout, H. J. Smith, and J. Vecchio; trustees: C. J. Redfern, L. B. Goler, C. E. Mason; sgt.-at-arms, A. Hill; exec. board: the pres., rec. sec., v.-p. and following. B. Blackford, G. Howitt, F. Closser, M. M. Mitchell.

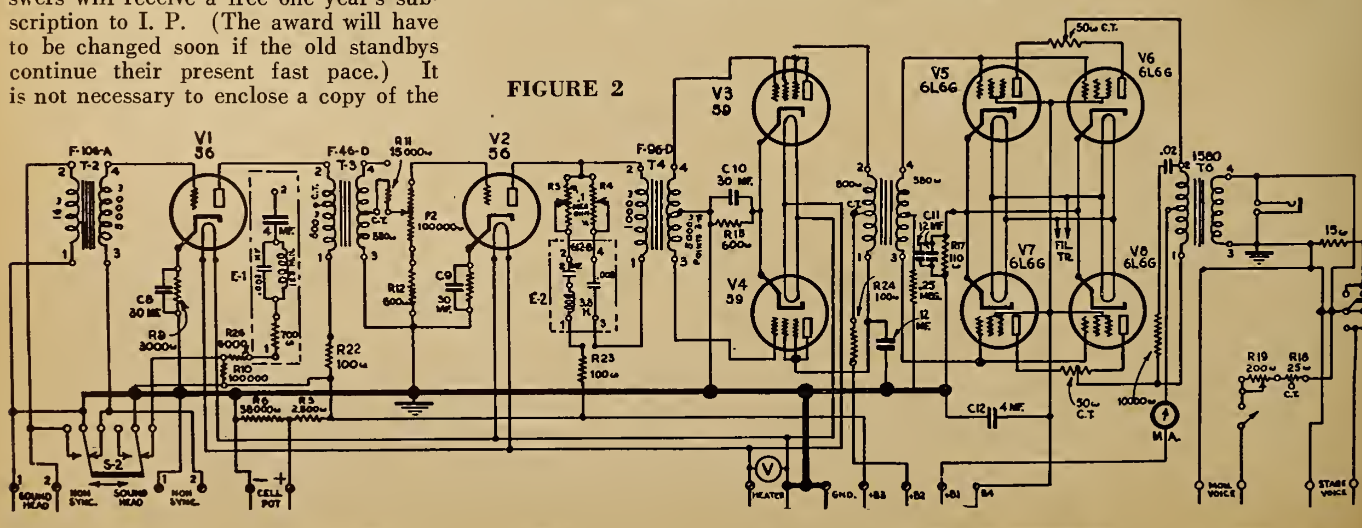


FIGURE 2

The Projectionist's Part in Efficient,

Economical Sound System Installation

By *ADOLPH GOODMAN*
SERVICE DEPT., RCA MFG. CO., INC.

ONE of the primary considerations for good operation of sound motion picture equipment and excellent reproduction in the theatre is proper installation of the apparatus. While this statement may appear to be simply a repetition of that which is already known and accepted as being a fact, cases still occur where lack of attention by the exhibitor before and during the installation period creates conditions which make impossible smoothest operation and best reproduction.

Since the projectionist is held responsible by the audience and the management for noticeable flaws in the screen presentation, it is definitely important that projectionists everywhere realize fully the extent to which *they personally can influence the conditions at fault*, and that they assist to the best of their ability in avoiding improperly made installations.

Exhibitors who purchase a new equipment are furnished with complete "Exhibitors Installation Instructions" showing exactly how the projection room and stage equipment are to be arranged and how the conduit and wires are to be run. It is assumed that the exhibitor prior to calling for the services of the factory engineer will have his electrical contractor and theatre personnel mount the various pieces of apparatus (with the exception of the soundheads), install the required conduits, and pull in the wires required.

● **Prolonged Supervision Costly**

The completion of this work prior to the arrival of the factory engineer means that the engineer is then free to devote his full attention to the final connections, adjustments and tests.

The established sound equipment manufacturer knows from years of experience that he must maintain an organization to assist the exhibitor at installation time and for servicing after the installa-

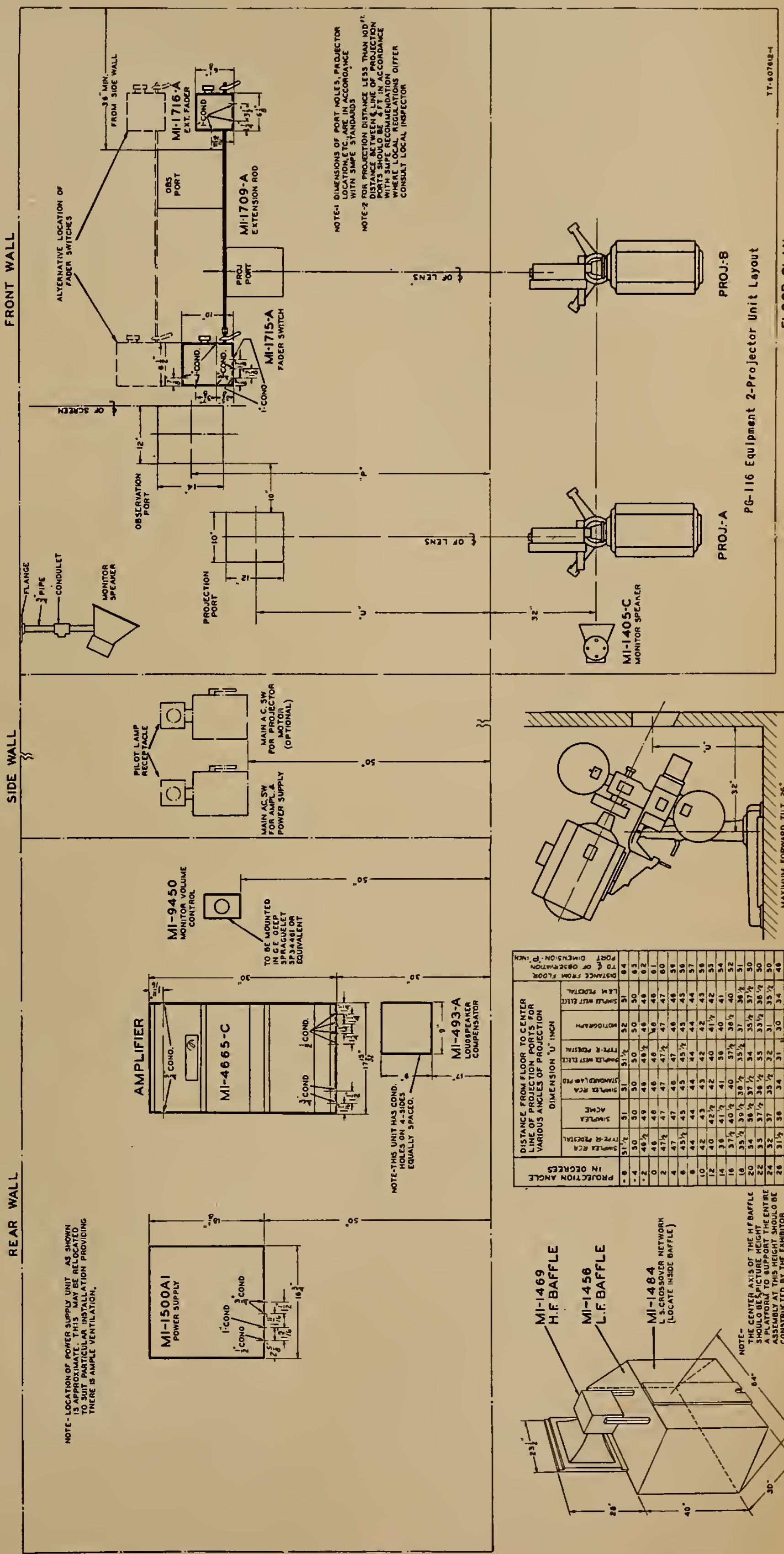


FIGURE 1. *PG-116 Equipment 2-Projector Unit Layout*

tion is completed. Allowance for a longer period of factory supervision than that outlined previously, however, must necessarily be reflected in higher equipment prices. Since the system, generally speaking, is adequate when all available talent and ability is applied to the problem, it appears that the savings in equipment prices to the customer are justified.

Since sound picture apparatus is essentially electrical equipment having terminal boards for external connections, this plan ordinarily presents no great difficulties, especially where the exhibitor is able to secure the services of a competent electrical contractor who is familiar with such apparatus and the problems peculiar to such an installation. It is when such an experienced contractor is not available that difficulties may arise. In such instances the apparatus may not be located to best advantage; or the contractor may not start the work at all, with the result that an intensive period of activity is required to meet the opening date or the date scheduled for changeover to the new sound system.

Regardless of the conditions involved, the assistance of the projectionist generally can contribute very materially toward obtaining an installation which is correctly planned, and mechanically and electrically sound. Projectionists have now had many years experience with all makes and types of sound equipment. Many of them have assisted in a number of sound system installations. All are familiar with the functions of the various pieces of apparatus involved, the approximate needs of a given piece of apparatus with respect to accessibility and ventilation, and the type of wiring materials used for inter-apparatus wiring. Therefore, they are well qualified to assist the contractor and exhibitor in arriving at an interpretation of the wiring specifications that is best suited to their particular projection room. Projectionists should not feel reluctant about offering to their employers their assistance on matters so vital.

● Drawings Aid Installation

Furthermore, of all the theatre personnel, the projectionists are undoubtedly best fitted to assume responsibility for supervising the checking and disposition of the equipment upon its arrival. They are best able to check the shipment for missing items and possible damage en-route, and then can best segregate the items for the stage from those for the projection room. Likewise, with their knowledge of apparatus, they can best determine how the apparatus should be handled and how it should be stored pending installation.

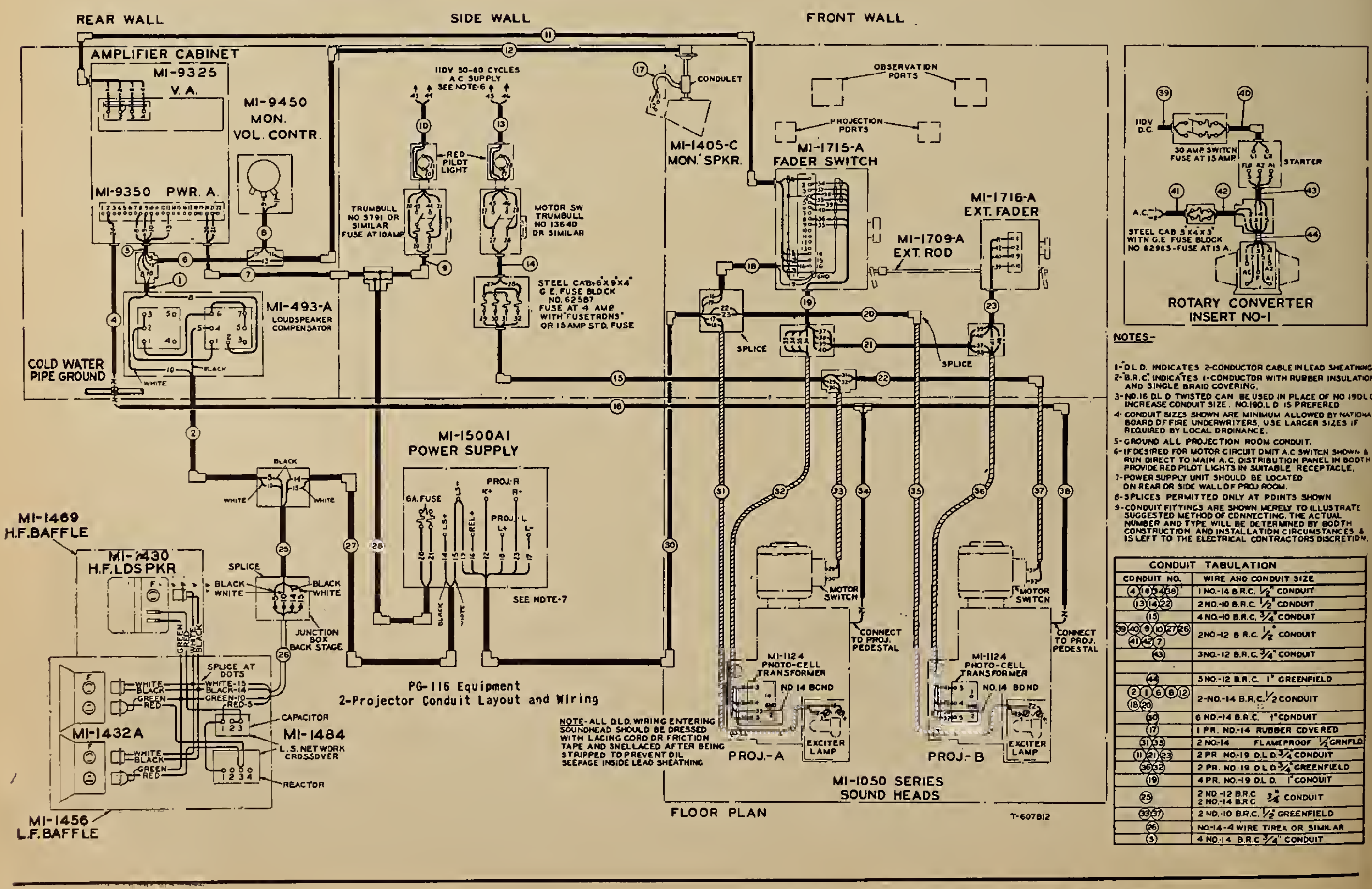
To simplify the installation work and to present the instructions for equipment placement, conduit and wiring in an easily understandable manner, RCA has developed a new type of composite drawing. Such drawings are contained in the complete instructions given to each exhibitor at the time of equipment purchase.

Typical examples of the drawings are shown in Figs. 1 and 2 for equipment suitable in theatres of 1000 seats and up to 150,000 cubic feet. It will be noted that the drawing of the projection room is "unfolded" to allow all the walls and the floor to be shown in nearly their proper relationship.

In the upper right-hand corner is the front wall indicating the location of the fader equipment in relation to the projection and observation ports. To the left of the view is shown the side wall with approximate locations of the power switches. On the extreme left are shown the approximate locations of the amplifier and power supply units together with the additional auxiliary equipment. The conduit knockouts in each piece of apparatus, with dimensions, are also shown so that the equipment locations may be selected before the apparatus actually arrives at the theatre.

The assembly of the high- and low-frequency baffles are shown in the lower left-hand corner with overall dimensions so that proper space behind the screen will be available. The complete layout

FIGURE 2. *PG-116 Equipment 2-Projector Conduit Layout and Wiring*



CONDUIT TABULATION	
CONDUIT NO.	WIRE AND CONDUIT SIZE
4 16 34 38	1 NO.-14 B.R.C. ½" CONDUIT
13 14 22	2 NO.-10 B.R.C. ½" CONDUIT
15	4 NO.-10 B.R.C. ¾" CONDUIT
39 40 9 10 27 26 41 42 7	2 NO.-12 B.R.C. ½" CONDUIT
43	3 NO.-12 B.R.C. ¾" CONDUIT
44	5 NO.-12 B.R.C. 1" GREENFIELD
2 1 6 8 12 18 20	2-NO.-14 B.R.C. ½ CONDUIT
30	6 NO.-14 B.R.C. 1" CONDUIT
17	1 PR. NO.-14 RUBBER COVERED
31 35	2 NO.-14 FLAMEPROOF ½" GRNFLD
11 21 23	2 PR NO.-19 D.L.D. ¾" CONDUIT
36 32	2 PR. NO. 19 D.L.D. ¾" GREENFIELD
19	4 PR. NO.-19 D.L.D. 1" CONDUIT
25	2 NO.-12 B.R.C. 2 NO.-14 B.R.C. ¾" CONDUIT
33 37	2 NO.-10 B.R.C. ½" GREENFIELD
26	NO.-14-4 WIRE TIREX OR SIMILAR
5	4 NO.-14 B.R.C. ¾" CONDUIT

is made in accordance with the recommendations of the S.M.P.E.

Figure 2 is a composite drawing showing the conduits and electrical wiring attached to the terminal boards of the various pieces of apparatus. The layout follows that of Fig. 1, with each piece of equipment shown in its approximate location in the projection room. Each conduit is numbered, and the tabulation at the lower right-hand corner give the conduit size together with the size and number of wires in each. Each wire is also numbered so that the connections at the terminal boards can easily be made.

For example, wire No. 1 in Conduit No. 11 connects to terminal No. 1 at the MI-9325 V.A. in the amplifier cabinet and also to terminal No. 14 in the MI-1715-A fader switch on the front wall. In like manner, wire Nos. 2, 3 and 4 connect, respectively, to terminals Nos. 15, ground, and 1 in the fader switch. From the tabulation it is seen that conduit No. 11 is ¾ inch and carries 2 pair No. 19 D. LD. (No. 19 twisted pair in lead sheath). In like manner, the other conduits and wires may easily be identified and the proper terminals connected together.

Upon receipt of the installation instructions, of which the two drawings are a part, the projectionist should study the text and layouts carefully. An examination of the conduit tabulation together with the conduit layout should give a fair approximation of the amount of conduit, wire and other electrical fittings required for the job. One of the important considerations in this respect is to be sure the electrical contractor has or is able to obtain quickly the No. 19 twisted pair lead-sheathed wire and the 4-wire Tirex or similar cable. In many cases it will be necessary to order this material special from an electrical supply house in one of the larger cities.

After a complete study of the electrical requirements has been made, a conference with the electrical contractor will result in a mutually better understanding of the installation procedure. It should be borne in mind that the electrical fittings specified are standard wiring accessories, with the exception of the lead cable and Tirex cable, and therefore should be easily obtainable. Also the layout has been prepared to conform with the National Electrical Code, but there may be local ordinances which should be checked with the local inspection officials.

A logical plan to follow during the preliminary stages of installation before the manufacturer's engineer arrives on the job is as follows:

1. Upon arrival of equipment check each package or carton against the shipping voucher to be sure all have been received.

2. Place the shipping crates containing speakers and baffles on or near the stage. Place the other packages and cartons adjacent to the projection room.

3. Before opening any shipping carton, study the Installation Instructions carefully and open only those which are to be installed before the engineer arrives. This includes all equipment except loudspeaker mechanisms, soundheads and tubes. Before discarding shipping cartons, examine them carefully to be sure all equipment parts have been removed.

4. Study the drawings furnished and be familiar with the proposed location of equipment in the projection room. Assist the electrical contractor in determining the material required for installation.

5. Assemble the loudspeaker baffles, on the stage, but do not install the loudspeakers.

6. Before asking for the manufacturer's engineer, be sure all preliminary work as called for in the Installation Instructions has been carried out. This requirement as pointed out is important since the engineer should be free to devote most of this time to final adjustment and tune up of equipment. If he must devote a good deal of attention to completing unfinished electrical work, which should have been done by the electrical contractor, he will be unable to devote as much attention to adjustments and listening tests as may be desirable.

In conclusion it can be said that many projectionists have already carried out a plan similar to that covered in this article, with correspondingly excellent results.

N. L. R. B. Suggests Voiding of I. A. Studio Pact; A. S. C. Move

Bombshell was exploded by National Labor Relations Board office in Hollywood when its director proposed that the 1935 Basic Studio Agreement be abrogated with respect to the four studio locals of the I. A. T. S. E. Suggestion followed series of conferences between N.L.R.B., studio officials and I. A. leaders following charges of "company unionism" made against the I. A. by a dissident faction within its ranks. Three additional points were advanced:

(a) Consent by all parties to a bargaining agency election.

(b) Studios to comply with a cease and desist order to enforce the agreement.

(c) Studios to post a notice setting forth the various points.

Such an election would be held to determine whether the basic agreement now effective under N.L.R.B. regulations still applies to present membership.

Coincidently, the American Society of Cinematographers, which now holds a collective bargaining agreement with major studios for all first cameramen petitioned the N.L.R.B. for certification as sole bargaining agent for all cameramen and their assistants. I. A. pact with studios now includes all classifications except "firsts".

I. A. officials were quick to voice opposition to the N.L.R.B. proposal. stating that it will press for a renewal of the pact. I. A. is expected also to oppose A.S.C. move for recognition. Statement issued by I. A. expressed doubt that N.L.R.B. had received 2,000 complaints from its members, as reported, and added: "No move by a disgruntled minority is going to be allowed to jeopardize the security of a satisfied majority."

WHITE HOUSE PROJECTOR GOES TO SMITHSONIAN INSTITUTE

Simplex projector, originally given to the late President Woodrow Wilson by Douglas Fairbanks Sr., is accepted for the Institute by Dr. Olmstead (right) for the Institute from I. A. Local 224, represented by Frederick Gooch, one of the projectionists who handled this equipment

Theatre Structure, Screen Light and Revised Projection Room Plans

A REPORT OF THE PROJECTION PRACTICE COMMITTEE OF THE S. M. P. E.†

This, the second and concluding instalment of this noteworthy report, presents data anent proposed revisions of the NFPA regulations for handling film. The first section, published last month, discussed theatre structure, screen illumination and suggested changes in plans for an ideal room. Comment from the field on this report is invited; address either the S. M. P. E. at Hotel Pennsylvania, N. Y. City, or this publication.

GENERAL ventilation of the projection room and rewind room shall be provided by a duct having outlets at one or more points in the ceiling and leading directly to the outer air. Said duct shall be capable of maintaining a natural circulation of air, without blower or fan, at the rate of not less than 20 cubic-feet per minute. Auxiliary circulation in said duct shall be provided by an exhaust fan or blower having a capacity of not less than 200 cubic-feet per minute for normal circulation and having a rated capacity of not less than 2000 cubic-feet per minute for operation in emergency, *i. e.*, fire.

In no case shall the exhaust duct system of the room be connected with the ventilating system of the building proper. The emergency operation of said fan shall be controlled by a switch (Fig. 5) operated automatically by the shutter control mechanism when the latter is actuated either manually or by melting of the fusible links. This exhaust fan, providing general and emergency ventilation of the projection room and rewind room shall be connected to the emerency lighting circuit of the room, and shall be controlled for normal circulation by a switch and pilot lamp within the room.

The ducts shall be of incombustible material, and shall be kept at least 2 inches from combustible material or separated therefrom by approved non-combustible heat-insulating material, not less than 1 inch thick.

Projection rooms and rewind rooms shall have two or more separate fresh air intake ducts at or near the floor and at opposite ends of the room, entirely independent of and in no way connected to the exhaust ducts of the room. Such air intake ducts may be connected into the main ventilating system of the building. (See Fig. 4 for general arrangement.)

● Port Shutters

(9.1) *Construction.*—Each port opening shall be provided with a gravity shutter of approved construction. Said shutter and guides shall be made of not less than 10-gauge iron, and the shutter should set into the guides not less than 1 inch at sides and bottom and overlap the top of the port opening by not less than 1 inch, when they are closed. Guide parts should preferably be welded. Shutters shall be suspended, arranged, and inter-connected, so that all port shutters will close upon the operating of some suitable fusible or mechanical releasing device, designed to operate automatically in case of fire or other contingency requiring immediate and complete isolation of the contents of the projection room from other portions of the building.

Each shutter shall have its own individual fusible link directly above it. A fusible link shall be located also above each upper projector magazine, which upon operating shall close all the shutters. There shall also be provided suitable means for manually closing all shutters simultaneously from any projector head and from a point near each door within the projection room. Shutters shall be free-acting. Shutters on openings not in use shall always be kept closed. Fig. 5 indicates one of many ways of arranging the shutter control system. All large shutters such as for spotlamps and special-effect machines (when used) shall be provided with weights to facilitate operating them manually.

(9.2) *Noise Transmission.* — The Committee recommends the use of means other than glass in projection ports to prevent transmission of noise from the projector room to the auditorium, such as reducing the free aperture of the port to the minimum size necessary for projection by use of fire-proof sound baffles.

Observation ports shall be fitted with a good grade of plate glass set in a metal frame at an angle to the vertical to avoid direct reflection, and easily removable from the inside of the projection room for cleaning. The purpose of this glass is to prevent transmission of noise into the auditorium.

● Heating Facilities

(10.1) *General.* — Proper provision shall be made for heating the projection room. The same facilities used for heating the theatre should be extended to the projection room.

● Painting, Floor Covering

(11.1) *Painting.*—The color of the walls shall be olive green to the height of the acoustic plaster. The latter should be painted in accordance with the instructions of the manufacturer of the material, preferably a dull buff color. The ceiling should likewise be painted white. All iron work of the projection ports shall be covered with at least two coats of flat black paint.

(11.2) *Floor Covering.*—Where local regulations permit, the floors of the projection room and rewind room should

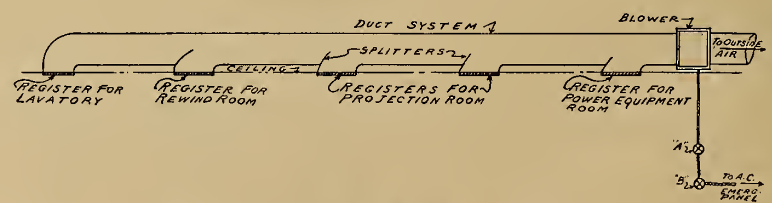


FIGURE 4

General and emergency ventilation system: normal blower capacity 200 cu.-ft. per min.; emergency capacity 2000 cu.-ft. per min.

(A) Switch and pilot lamp for normal operation, inside projection room; (B) switch and pilot lamp for normal operation, outside door of projection room; also connected to port fire-shutter control mechanism.

(Two or more fresh-air intakes required at or near the floor at opposite ends of the room)

†J. Soc. Mot. Pict. Eng., XXXI (Nov., 1938), No. 5.

be covered with a good grade of battleship linoleum cemented to the floor. The floor covering should be laid before the equipment is installed.

● General Room Equipment

(12.1) *Projection Room.*—All equipment to be used in the projection room should be of approved type, including the projectors, arc lamps, sound equipment, *etc.* All shelves, furniture, and fixtures within the projection suite shall be constructed of metal or other incombustible material. A metal container for hot carbon stubs shall be provided. Adequate locker space shall also be provided.

(12.2) *Rewind Room.* — In the rewind room shall be provided an approved fire-proof film safe or cabinet, a table, an approved rewind equipment, a splicer, and an approved scrap film can. The film safe or cabinet shall be capable of holding 25,000 feet of 35-mm. film.

All tables and racks and all furniture shall be of metal or other non-combustible material and should be kept at least 4 inches away from any radiator or heating apparatus. Tables shall not be provided with racks or shelves beneath them whereon may be kept film or other materials. The scrap film can shall have an automatic-closing hinged cover and so arranged that the scrap film is kept under water at all times.

Quantities of collodion, amyl acetate, or other similar inflammable cements or liquids kept in the rewind room for the purpose of splicing film, shall not exceed ½ pint. No stock of inflammable materials of any sort whatsoever shall be permitted within the rewind suite except as specifically mentioned herein.

All splices of film shall be made with approved mechanical cutting and splicing machines. No hand cutting or splicing shall be permitted. Film shall be kept in the film cabinets at all times except when being projected or rewound. Any films in addition to those used for the current showing or in excess of that permitted by local authorities shall be kept in their original shipping containers.

(12.3) *Fire Extinguishing Equipment.*—Local authorities having jurisdiction over fire extinguishing equipment should be consulted regarding the proper types, numbers, and locations.

(13.1) "No smoking" signs should be posted in prominent places and matches should not be carried by any employee.

(13.2) *Operation.* — Motion picture projectors shall be operated by and shall be in charge of qualified projectionists who shall not be minors. The projectionist should be stationed *constantly* at the operating side of the projector while it is in operation. A proper factor of safety in operation, as well as avoidance of imperfect operation of projection equipment, or unjustified interruptions of service can be attained only by having an adequate personnel in the projection room.

(13.3) *Action in Case of Fire.*—In the event of film fire in the projector or elsewhere in a projection or rewind room, the projectionist shall immediately shut down the projector and arc lamps, operate the port shutter release at the point nearest him, turn on the auditorium lights, leave the projection room immediately, and notify the manager of the theatre or building. An automatic switch is recommended for the electrical operations mentioned.

● Revised Fire Regulations

For a long time it has been recognized that numerous conflicts existed between the provisions of the *Regulations of the National Board of Fire Underwriters for Nitrocellulose Motion Picture Film* and the *National Electric Code.* In addition, when the revision of the Projection Room Plans issued by the Projection Practice Committee in 1935[1] was brought to the attention of the National Fire Protection Assn., a number of conflicts between the *Plans* and the *Regulations* were discovered. In view of this confusion, steps were taken by the NFPA to make their Committee on Hazardous Chemicals and Explosives, authors of the *Regulations,* responsible for the preparation of all material relating to motion picture fire prevention. All such material to appear in future issues of the National Electric Code will be taken from the revised *Regulations.*

To assist in this work, the Projection Practice Committee of the SMPE agreed to submit its recommendations for revising the portions of the *Regulations* pertaining to projection rooms, with respect to which most of the conflicts have occurred. Such recommendations have been prepared and have been submitted to the NFPA.

In the following proposals, sections of the *Regulations* pertaining to exchanges, studios, storage vaults, *etc.,* not dealing with projection or projection rooms, were not considered. Where no change is proposed, the section is marked *"Unchanged"*; added words or clauses are underlined; sections completely rewritten are marked *"Rewritten"*; proposed new sections are marked *"New"*; sections recommended for deletion are marked *"Deleted."*

Attention should be called to one very important departure in these proposals: In the original *Regulations,* structural details of permanent projection rooms and temporary projection booths were grouped together in the same sections and sub-sections (Sec. 191). The Committee deemed it advisable to remove from Section 191 all references to temporary projection booths; and since it is recommended that the existing Section 192 be deleted from the *Regulations,* the material pertaining to temporary projection booths may be assigned to this Section 192 . . .

(127) Motion picture projectors *and associated electrical equipment* shall be of approved type and safeguarded in accordance with the requirements of the *National Electric Code,* Article 540.

(128) (*New Section*) Motor Generator sets, transformers, rectifiers, rheostats, and similar equipment, for the supply or control of current to arc lamps on projectors, shall if practicable, be located in a room separate from the projection room or booth. Such separate room shall be suitably ventilated. No rheostats exceeding 30-ampere capacity shall be installed in a projection room or booth.

Motor-generator sets shall have the commutator end or ends protected as provided in the *National Electric Code,* Section 5310. Rheostats shall be constructed and installed as provided by the *National Electric Code,* Article 470.

When motor-generators, transformers, rectifiers, and similar equipment are installed in the projection room or booth, they shall be so located and guarded that arcs or sparks caused thereby can not come into contact with film, and shall be so located as to provide at least 30 inches of clear aisle space between any two pieces of equipment where walking is necessary. Rheostats for arc lamps (not exceeding 30-ampere capacity) when in-

[1] Report of Projection Practice Committee, J. Soc. Mot. Pict. Eng., XXV (Oct., 1935), No. 4, p. 341,

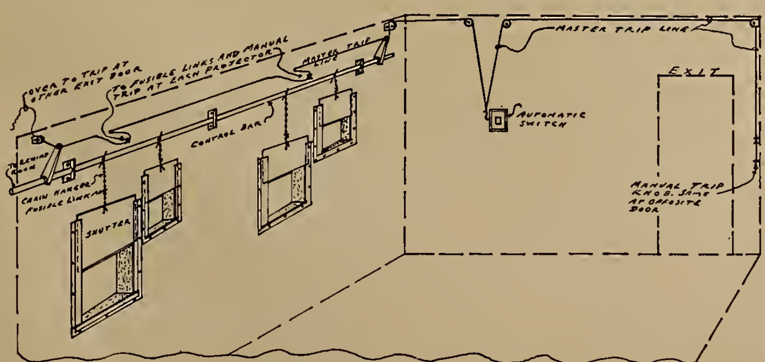


FIGURE 6

One of many possible arrangements of the port fire-shutter control. The automatic switch operates the exhaust fan and emergency lights.

stalled in the projection room or booth shall be installed near the ceiling upon suitably supported heavy metal shelves provided with metal pans having upturned sides. The rheostats shall be electrically- and heat-insulated therefrom . . .

Section 19—Motion Picture Projection and Special Processes

(191) (*Rewritten*) *Permanent Enclosures for Motion Picture Projectors.*—Enclosures are classified into two types, permanent and temporary. The permanent type of enclosure in permanent installations are known as *Projection Rooms;* the temporary type of enclosure as *Temporary Projection Booths.*

(*a*) *Projection Rooms.*—Motion picture projectors using nitrocellulose film in structures or buildings definitely intended for motion picture exhibition purposes shall be operated or set up for operation only within an approved projection room. For one machine the projection room shall be not less than 8 feet wide by 10 feet deep by 8 feet high; and for two machines, not less than 14 feet wide by 10 feet deep by 8 feet high. Not less than 30 inches of clear aisle space where walking is necessary, shall be allowed between any two pieces of equipment or between projectors.

Note.—Motion picture projectors capable of operating *only* with 35-mm. cellulose acetate film (*i. e.,* slow-burning or non-inflammable film) may be operated without an enclosure but only by permission of local authorities having jurisdiction.

(*b*) The projection room walls shall be built of brick, tile, or plaster blocks plastered on the inside with ¾ inch of cement plaster, or all concrete. The core of the wall shall be not less than 4 inches thick. When plaster block is used it shall be supported upon a steel framework.

The ceiling shall be constructed of 4-inch concrete slabs or precast concrete; it may be constructed of 3-inch plaster blocks supported by a steel structure and plastered on the inside with ¾ inch of cement plaster.

Note.—Approved fire-proof acoustic material may be used on ceiling and walls above a height of 4 feet from the floor.

The floor shall be a reenforced concrete slab not less than 4 inches thick.

All projection room construction shall be supported upon or hung from fireproof structural steel or masonry.

All exposed steel shall be covered with a minimum of 1½ inches of cement plaster.

(*c*) Two doors shall be provided, one at each end of the projection room, each at least 30 inches wide by 6 feet high. They shall be of the approved one-hour fire-test type and shall be arranged so as to close automatically, swinging outwardly, and shall be kept closed at all times when not used for egress or ingress. It shall be possible at all times to open either door from the inside merely by pushing it. Door jams shall be of steel.

These exits shall be provided strictly in accordance with regulations of local authorities having jurisdiction, particularly with reference to other sizes and locations. At least one of these exits should be of the conventional stairway type, with risers not in excess of 9 inches and a minimum tread to each step of not less than 7 inches. Stairs shall be sufficiently wide to permit easy egress.

(*d*) Two orifices or openings for each motion picture projector or stereopticon shall be provided: one for the projectionist's view (observation port) shall not be larger than 200 square-inches, and the other, through which the picture is projected (projection port) shall be not larger than 120 square-inches. Where separate spotlight or floodlight machines are installed in the same projection room with motion picture projectors, not more than one port opening for each such machine shall be provided for both the operator's view and for the projection of the light, but two or more machines may be operated through the same port opening. Such port openings shall be as small as practicable, and in any case shall not exceed 7½ square-feet in area.

(*e*) Each port opening shall be provided with a gravity shutter of approved construction. Said shutter and guides shall be made of not less than 10-gauge iron, and the shutter shall set into the guides not less than 1 inch at sides and bottom and overlap the top of the port opening by not less than 1 inch, when closed. Shutters shall be suspended, arranged, and interconnected so that all port shutters will close upon the operating of some suitable fusible or mechanical releasing device, designed to operate automatically in case of fire.

Each shutter shall have its own individual fusible link directly above it. A fusible link shall be located also above each upper projector magazine, which upon operating shall close all the shutters. There shall also be provided suitable means for manually closing all shutters simultaneously from any projector head and from a point near either door within the projection room. Shutters shall be free-acting and regularly tested. Shutters on openings not in use shall always be kept closed.

(*f*) All shelves, furniture, and fixtures within the projection room shall be constructed of metal or other incombustible material. No stock of inflammable material of any sort whatever shall be permitted or allowed to be within the projection room, except what is required for the regular and immediate operation of the equipment, the films used in the operation of the machines, and film cement. (See Sec. 214.)

(*g*) In permanent projection rooms, ventilation shall be provided for the arc lamps independently of the general and emergency ventilating system of the room. Each projector arc lamp housing shall be connected by a flue to a common duct, which duct shall lead directly out-of-doors and shall contain an exhaust fan or blower having a capacity of at least 50 cubic-feet per minute of air for each projector arc lamp connected thereto. This exhaust fan or blower shall be electrically connected to the projection room wiring system and controlled by a switch with pilot lamp within the room. There shall at no time be less than 15 cubic-feet of air per minute flowing through each lamphouse into the exhaust system connected to the air outside the building.

General Room Ventilation

General ventilation of the projection room shall be provided by a duct having outlets at one or more points in the ceiling and leading directly to the outer air. Said duct shall be capable of maintaining a natural circulation of air, without blower or fan, at a rate of not less than 20 cubic-feet per minute. Auxiliary circulation in said duct shall be provided by an exhaust fan or blower having a capacity of not less than 200 cubic-feet per minute for normal circulation and having a rated capacity of not less than 2000 cubic-feet per minute for operation in emergency, *i. e.,* fire. In no case shall the exhaust duct system of the room be connected with the ventilating system of the building proper.

The emergency operation of said fan shall be controlled by a switch operated automatically by the shutter control mechanism when the latter is operated either manually or by melting of the fusible links. This exhaust fan providing general and emergency ventilation of the projection room, shall be connected to the emergency lighting circuit of the room, and shall be controlled for normal circulation by a switch and pilot lamp within the room.

The ducts shall be of incombustible material, and shall be kept at least 2 inches from combustible material or separated therefrom by approved non-combustible heat-insulating material not less than 1 inch thick.

Projection rooms shall have two or more separate fresh-air intake ducts at or near the floor and at opposite ends of the

(*Continued at foot of next page*)

No Projectionist Award: Room Not a 'Workshop', Says Court

Oklahoma State Supreme Court has set aside a compensation award of $3125 to Albert George Johnson at the rate of $10 per week for burns he suffered while operating a projection machine for Oscar Berry, owner of the Fox at Ardmore, Okla. Johnson claimed permanent total disability of his right hand and partial disability of the left.

Six justices concurred in the opinion that State laws do not class occupation in the theatre industry as hazardous employment and the fact that there were electric motors, generators and projectors present does not classify a projection room as a "workshop," which would bring it within the Oklahoma workmen's compensation laws.

COMMON ELECTRICAL UNITS

A knowledge of the four most commonly used electrical units will be found very useful to anyone who deals with light sources.

Volt (*Unit of Pressure*): The volt is the unit of electrical pressure corresponding to pounds per square inch of water pressure, and is named after Allesandro Volta who discovered the chemical means of generating electricity. One volt is the electrical pressure or electromotive force generated by a standard cell or battery constructed in a standardized way of carefully specified materials.

Ampere (*Unit of Flow*): The ampere is the electrical unit of current flow corresponding to cubic feet per minute or gallons per minute for water flow. Technically, it is the unvarying rate of current flow which will deposit 0.001118 grams of silver per second from a standard silver nitrate solution. It is named after Andre Ampere, who was Professor of Mathematics in the Polytechnic School of Paris.

Watt (*Unit of Power*): The watt is the electrical unit of power corresponding to horsepower, and is named after James Watt, inventor of the steam engine. It is the product of volts x amperes (pressure x quantity per second)* and represents the rate of doing work. One horsepower is equivalent to 746 watts. The kilowatt is 1000 watts.

Watthour (*Unit of Work*): The watthour is the electrical unit of work and is the product of volts x amperes x time. An analogous term is horsepower-hours. It represents the rate of doing work (power) multiplied by the time during which this work is being done. It should not be confused with power, which is rate of doing work, just as velocity is rate of motion.

*In some special alternating current circuits (where the voltage and current are said to be out of phase) this product must be further multiplied by another term called *power factor*.

THEATRE STRUCTURE, ROOM PLANS, SCREEN LIGHT

(*Continued from preceding page*)

room, entirely independent of and in no way connected to the exhaust ducts of the room. Such air intake ducts may be connected into the main ventilating system of the building.

(192) (*Delete*) Not more than five motion picture projectors shall be located in one room, unless the projectors are of a type using incandescent electric lights of not over 25-watt size, when not more than ten projectors shall be located in one room.

(192) (*New Section*) *Temporary Projection Booth.*—Motion picture projectors using nitrocellulose film, when used in other places than in permanent enclosures, (*i. e.*, in *projection rooms*), shall

be set up and operated in a temporary enclosure known as a *Temporary Projection Booth.* However, such temporary projection booths shall be installed only by permission of local authorities having jurisdiction, and then only for a limited number of exhibitions of motion pictures in a structure or building suitable therefor and not regularly licensed for such purpose. In no case shall temporary projection booths be allowed as part of the structures or buildings definitely intended for motion picture exhibition purposes.

(*a*) Temporary projection booths shall conform to Section 191 (*a*) with regard to dimensions.

(*b*) The sides, walls, and ceiling shall be constructed of ¼-inch hard sheet asbestos board, and the floor of ⅜-inch hard sheet asbestos board, the whole securely riveted or bolted to a rigid metal frame of not less than 1¼ by 1¼ by ¼-inch angle-irons properly braced. The sheet asbestos boards shall sheath the entire interior of the frame work, and no metal frame supports shall be allowed to remain exposed within the enclosure. All joints shall be made as air-tight as possible to prevent the discharge of smoke.

(*c*) One entrance door shall be provided which shall conform to the requirements for the main entrance door of Section 191 (*c*) with the following exceptions:

(1) the fire resistance of the door shall be equivalent to the fire resistance of the rest of the construction, and

(2) clear aisle space or passageway shall be provided around the projection booth and from the entrance door thereof to the nearest exit of the structure or building in which the projection booth is installed.

(*d*) Observation and projection ports shall conform to the specifications of Section 191 (*d*).

(*e*) Port shutters shall conform to the requirements of Section 191.

(*f*) All shelves, furniture, and fixtures within the projection room shall conform to the requirements of Section 191(*f*). There shall additionally be provided an approved can for scrap film, having an automatically closing hinged cover; also a similar container for receiving hot carbon stubs, said container to be partly filled with sand.

(*g*) The ventilation system of the temporary projection booth shall conform to all the requirements of Section 191(*g*).

(*h*) Rewinding film in temporary projection booths, as in permanent, shall be done in accordance with Section 212(*c*).

(*i*) Quantity of film contained within a temporary projecton booth shall be in accordance with Sub-Section 213(*a*) (3).

(*j*) Projection equipment in temporary projection rooms shall be operated in accordance with Section 213.

(193) *Processing Film.*—The processing of film, as cleaning, polishing, buffing, and other special treatment, shall not be done in rooms *where* other operations *are performed, except that in the case of motion picture theatres, such processing or cleaning of film shall be done in the rewind room.* See Section 212(*a*).

Special processes for treating film shall be provided with such proper safeguards as are necessary for protection against the hazards involved. The inspection department having jurisdiction shall be

consulted in regard to the protection needed.

(196) *(Unchanged) Film Cement.*—Compounds of all collodion, amyl acetate, or similarly inflammable cements shall not be kept in the rooms where they are used, in quantities greater than 1 quart; and such material in excess of this quantity shall be kept in a vault. The use of these materials in motion picture theatres and other special occupancies is covered in Sub-Section 214.

(197) *(Unchanged) Smoking.*—Smoking, except in rooms especially provided for the purpose, should be prohibited in any establishment handling or storing film, and conspicuous *No Smoking* signs should be posted in prominent places. Matches should not be carried by any employee.

SPECIAL PROVISIONS FOR SPECIAL OCCUPANCIES

Section 21—Theatres and Other Occupancies in Which the Principal Use of Film Is in Motion Picture Projection

(211) *Enclosure for Projectors.*—Motion picture projectors shall be installed in a projection room in accordance with Sub-Section 191.

(212) *(Rewritten) Rewinding.*—*(a)* Rewinding film is permitted in permanent projection rooms (but not recommended) when projectors and lamps are not in use. There shall be provided an approved can for scrap film, having an automatically closing hinged cover. When rewind table and approved film cabinets are in the projection room, such table and cabinets must be at least 30 inches from the rear of any projector.

(b) Where rewinding of film in permanent installations is done in a separate room, at approved location adjacent to or near the projection room, such rewinding rooms shall be of construction similar to that of the permanent projection room, as specified in Sub-Section 191. Such room shall be not less than 80 square-feet in area and shall have clear walking spaces not less than 30 inches wide. The ventilating system shall be connected directly to the outside air and shall conform, as to capacity, to the specifications of Sub-Section 191 *(g)*, and may be combined with the general ventilation system of the projection room.

(c) Rewinding film shall not be done in temporary projection booths except when projectors and lamps are not in use and are cool.

(213) *(Unchanged) Care and Use of Film.*—Motion picture film used in connection with the projection of motion pictures (as in theatres, motion picture theatres, screening or projection rooms, sound recording studios, and motion picture titling studios) shall be limited and kept as follows:

(a) *(Rewritten)* The quantity of film in any projection room or booth or rewinding room shall be limited to that given below:

(1) *(Rewritten)* In a projection room constructed to conform to Section 191: not exceeding 125 pounds (25,000 feet of 35-mm. film);

(2) *(Unchanged)* In a rewinding room constructed and vented to conform to Section 191 and Sub-Section 212 *(b)* and separated from the projection room with openings thereto protected with approved fire doors: not exceeding 125 pounds (25,000 feet of 35-mm. film);

(3) *(Rewritten)* In a temporary projection booth, constructed to conform to Sec-

tion 192: not exceeding 75 pounds (15,000 feet of 35-mm. film);

(4) (*Rewritten*) In a special room constructed and vented as required for rewinding rooms (see Sub-Sec. 212), when approved by the inspection department having jurisdiction: not exceeding 125 pounds (25,000 feet of 35-mm. film) may be kept in lieu of the amount permitted in either the projection room or the rewinding room. The total quantity in the three rooms shall not exceed 250 pounds (50,000 feet of 35-mm. film).

(*b*) The above quantities of film shall be kept as follows:

(1) Up to 40 pounds (8000 feet of 35-mm. film) of film may be kept in shipping containers, or approved cabinet, in each room;

(2) If the amount of film on hand exceeds 40 pounds, an approved cabinet shall be provided, in which the amount of film in excess of 40 pounds shall be kept.

● Inflammables Barred

(214) (*Unchanged*) No collodion, amyl acetate, or other similar inflammable cement or liquid in quantities greater than ½ pint shall be kept in the projection room or rewinding room.

(215) (*New Section*) All splices of film shall be made on approved mechanical cutting and splicing machines in approved manner. No hand cutting or splicing shall be permitted.

(216) (*Unchanged*) *Location.*—The number and location of motion picture projection rooms or booths in any non-sprinklered building shall be subject to the approval of the inspection department having jurisdiction.

(217) (*New Section*) *Operation.*—Motion picture projectors in permanent or temporary projection rooms shall be operated by and shall be in charge of qualified projectionists, who shall not be minors.

(218) (*New Section*) *Action in Case of Fire.*—In the event of film fire in the projector or elsewhere in a projection or rewind room, the projectionist shall immediately shut down the projection machine and arc lamp, operate the port shutter release at the nearest point to him, turn on the auditorium lights, leave the projection room promptly, and notify the manager of the theatre or building.

Academy Releases Revised Electrical Characteristics

The Academy of M. P. Arts and Sciences has issued a Technical Bulletin containing specifications for Revised Standard Electrical Characteristics to which theatre equipment should be adjusted to obtain the best possible sound reproduction.

The specified revisions have been drawn up to take advantage of advancements and changes in theatre equipment during the past year, and theatres adjusted to meet these characteristics will present their sound in the best possible manner.

Characteristics previously published were specified for various type systems all on one drawing. In the interest of clarity, in the current Bulletin each characteristic applying to specific systems is shown on a separate curve. It is planned to specify additional characteristics to cover additional reproducing systems from time to time.

New Film Laws Irk British Picture Technicians

BRITISH technicians are aroused at some of the regulations relating to motion picture exhibition promulgated by the authorities. Writing in the *Ideal Kinema*, R. H. Cricks, noted British technician, gives his views of these regulations.

"Is it not time that a stop was put to the ever-tightening requirements of local authorities?" says Mr. Cricks. "I refer to the recent stipulation that all screens must be incombustible, a word which is apparently being used as excluding any type of fabric, this notwithstanding that as far as I am aware, the screen has never been involved in a cinema fire. I was hearing the other day of the same authority's requirements for a fit-up show which resulted in the whole show being abandoned, notwithstanding that regulations were being fully complied with.

● Ignore Other Dangers

"Many such requirements are fully justified: an instance is in the case of the new Warner theatre, where the insistence upon the acoustic materials being entirely fireproof is quite admissible. But cases such as where an observation port provided near the dimmer board, enabling the projectionist to see the effect of his lighting, was required to be closed, are altogether unreasonable. Unfortunately, the exhibitor is rarely in a position to protest at such official interference.

"The remarkable thing is that real sources

of potential danger—such as projectors in bad mechanical condition and damaged films—seem to be altogether ignored. Yet a projector with hooked sprocket teeth, too harsh take-off or take-up, or worn gate-runner with sharp edges is a real source of danger."

RCA SERVICING GAINS

RCA has just closed three important servicing contracts: the 80 theatres in the Blank Circuit in the mid-West, 32 Commonwealth Circuit houses in Missouri, and 82 theatres in the Sparks Circuit in Florida. The latter also replaced five sound equipments with Photophone units.

L. W. DAVEE TO MOTIOGRAPH

Lawrence W. Davee has been appointed Eastern sales manager for Motiograph, Inc., and will concentrate on field assistance to the company's dealers. Davee is widely known in the industry through long service in various important posts including Fox-Case Corp., manager of Eastern Service Studios, and ERPI. He also handled the installation of Fox Grandeur equipment in key cities. He is a governor of the S.M.P.E. as well as its treasurer.

ALTEC SIGNS TWO CIRCUITS

Two large servicing contracts have been awarded to Altec Service Corp.—the Malco Theatres, Inc., will use Altec in 50 theatres in the South, as will the Skouras Theatres Corp. in its 58 theatres.

Altec has just announced the availability of group buying contracts for service through recognized exhibitors' organizations.

ST. LOUIS, CLEVE. PAY TILTS

New contract signed by I. A. Local 143 in St. Louis provides in a majority of situations for same scale as currently. About 50 of the smaller houses, however, were given a $2.50 weekly tilt.

Cleveland I. A. Local 160 has regained the 10 per cent pay-cut granted exhibitors early this Fall for for a 10-week period.

LOEW EXEC. TAKES AIRED

Charges that five Loew employes received $12,800,000 during the period from 1934 to 1937 while common stockholders received $21,612,000 during the same period were aired recently in the N. Y. Supreme Court before Justice Louis A. Valente in a minority stockholders' suit. Bernard J. Reis, an accountant, testified that he had made an examination of the books to determine the figures. The plaintiffs charge that the amount received as dividends was too low.

The five men who participated in the $12,800,000, according to Reis, were Louis B. Mayer, J. Robert Rubin, Nicholas Schenck, David Bernstein, Irving Thalberg and Arthur Loew.

EASTMAN EMPLOYEE BONUS

Eastman Kodak Co. has voted a 1939 wage dividend approximating $2,200,000 to be paid employees on March 27, 1939. Regular employees who are at work March 27 next year and who have worked all or part of 26 different weeks in 1938 will be eligible for the wage dividend—the 27th voted by Eastman since plan was begun in 1912.

Wage dividend voted recently will raise to $43,000,000 the total of wage dividends disbursed to date. In March this year the company voted a record $3,425,000 wage dividend.

P. A. UNIT MORE IMPORTANT IN PROJECTION ROUTINE

(Continued from page 11)

feedback previously mentioned. It is not acoustical (created by loudspeaker sound re-entering the microphone where it originated) but electrical and provided by wiring arrangements between the output circuit and the input circuit, or between a later and an earlier stage of amplification. Further, it is "reverse" feedback in that phase relations are so adjusted that the feedback current opposes instead of reinforcing the original sound current.

These distinctions should wholly clarify any possible confusion caused by similarity of names. Reverse feedback, by opposing the original sound current, cuts down the volume both of sound and of distortion, but of distortion more than of sound. It is consequently desirable as improving sound quality. Acoustic feedback is not merely undesirable but beyond a certain point makes reproduction impossible.

● **P. A. Speaker Arrangements**

Public address speaker systems present several requirements that differ entirely from those of sound picture equipment. One vital difference is the factor of illusion. In sound picture reproduction the speakers are usually located behind the screen, and those that emit voice frequencies are placed about two-thirds of the way up, directly behind the lips of the person supposed to be speaking. Thus

it is very easy to create the illusion desired.

With microphone reproduction there is generally no screen to hide the speakers, yet illusion still is desirable. Even when the microphone is in plain view, a well-planned installation creates the impression that the sound is heard directly. If the audience detects that it is coming from a side wall or some other remote part of the theatre, the worth of the performance is impaired. Furthermore, the sound may in that case be made indistinct and hard to understand by the interaction between the loudspeaker output and the direct voice of the person speaking. Consequently, speakers are almost always located at the front of the theatre, above or around the edges of the stage opening.

In this location they are close to the microphones, involving an obvious risk of feedback; thus flat baffles are uncommon, and directional baffles, to throw the sound forward and outward away from the stage, are the usual arrangement. Cellular speakers, similar to those of modern sound picture systems, are used, but in many houses are acoustically undesirable because their output cannot be closely controlled. They spatter sound about evenly, whch is a primary function of their design, but in p.a. work they may spatter some against a reflecting wall or cove that will throw back enough to cause feedback. In such conditions individual speakers with directional baffles that can be pointed separately and accurately are preferred.

Double-speaker systems, with frequency filters, such as are now common in sound picture installations, are seldom used. On the other hand, the speakers (like the microphones and the amplifier, and for the same reason) must be extremely flat in frequency response. It is easier to build a flat amplifier, or even a flat microphone, than a flat speaker. Consequently, p.a. installations subject to feedback troubles, may undergo seemingly miraculous cure through the installation of speakers of better grade.

● P. A. System Troubles

Electro-dynamic type p.a. speakers generally draw their field excitation from the p.a. amplifier. Separate exciter rectifiers are unusual, but are necessary in the larger systems and in those where amplification is handled by the normal projection room equipment. The most modern p.a. apparatus, however, strongly favors the permanent-magnet type of dynamic speaker, which is now available in high- as well as low-power units, thus eliminating the field supply problem.

Acoustic feedback is not the only difficulty encountered with p.a. apparatus which differs from the common forms of trouble met in sound picture operation. The microphone lines, for example, while similar in principle to the photo-electric cell arrangements found in many theatres, differ in the matter of enormously greater length, which makes them far more subject to noise pick-up. On the other hand, flutter is impossible in microphone reproduction, and of course there is no exciter lamp focus trouble or difficulty with drive gears.

The difference between the two equipments greatly facilitate the work of trouble-shooting wherever the same amplifier serves both or (as is sometimes the case) where it can be switched over in emergencies from one service to the other. Comparing sound picture and p.a. results at once eliminates many trouble possibilities and greatly reduces the amount of equipment that must be checked in detail.

Common p.a. microphone difficulties involve wrong placement, wrong positioning (with directional mikes); damaged mike line, imperfect mike connection (that is, loose plug contact, *etc.*); imperfect microphone ground (extremely important with high impedance units), and in the case of contact mikes, loose or imperfect connection with the musical instrument.

Electrical troubles in the mixer are not uncommon: in the pad type they are often matters of imperfect slider contact, as with any volume control, while the tube-type mixer is essentially an amplifier with a number of stages working in parallel, and as such subject to normal amplifier faults. The p.a. amplifier itself, when separate from the synchronous sound amplifier, presents special difficulties only in connection with its automatic volume control and automatic volume expander circuits, which ordinary theatre equipment does not have. The details of any given difficulty in those circuits will resemble normal amplifier troubles, involving defective resistors, condensers, tubes, connections or insulation—nothing markedly new or strange. P.A. speaker faults are in every way similar to those encountered in any theatre speaker.

P.A. maintenance presents entirely familiar problems in the way of periodic inspections and tests, routine cleanliness and adjustments, and stocks of spare parts. In the latter connection, however, it is important to remember that different types of microphones cannot readily be substituted for one another, while even such small differences as may be involved in a close-talking and distant-pickup microphone of the same make and model render undesirable replacement of one by the other.

Mr. Calvi takes his Projectionist's advice

It paid to instal Simplex E-7 PROJECTORS

National Theatre Supply Co.
1961 So. Vermont Ave.,
Los Angeles, Calif.

Gentlemen:

CHIEF PROJECTIONIST SAYS HE CAN IMPROVE PROJECTION WITH Simplex E-7

Several months ago, my chief Projectionist, John Seiler, came to me with the information that we could greatly improve our screen results and appearance by making a change in projection equipment.

THE BOSS SHOWS INTEREST

I have always felt that good projection was one of the first essentials of good showmanship in the theatre. For this reason, I was inclined to pay some serious attention to Mr. Seiler, and I accompanied him to the projection room where he proceeded to point out the various reasons why the equipment then in operation was not giving the audience all they were paying for.

DOUBTS PROJECTION CAN BE IMPROVED

I had always felt that our picture presented a better than average appearance and that the equipment was in good repair. The advances and improvements of this new Projector - the SIMPLEX E-7, seemed to me to be a little too fantastic, and I was not completely "sold" on the idea of making the change. There were no prior installations in medium-sized theatres to use as a criterion. I had only my Projectionist and a respect of his judgment to guide me, plus the assurance of Mr. Marx, the integrity of your concern, and my past satisfactory experience with SIMPLEX Projectors.

MR. CALVI INSTALLS Simplex E-7 SAYS IMPROVEMENT IS AMAZING

We finally made the change, and I am happy to report that we are very proud of the results we have achieved with the aid of Two E-7 Heads an Two Super-SIMPLEX Pedestals. If I hadn't seen it, I would doubt if it were possible to make such a difference in screen appearance. Except for an occasional print with some slight jump or side wobble in it, t picture maintains a steadiness that is AMAZING.

PATRONS EXPRESS DELIGHT LOCAL INTEREST IN PROJECTION GREATLY INCREASED

Technicolor subjects have a new importance on the program and screen. Our patrons remark about the absence of flicker and steadiness of picture, and if you know theatre patrons as I do, you know that it takes something big to make a patron comment on anything except the tempera ture. I'm playing up the change in my advertising, as you can see by the enclosed program, and I'm getting lots of interest in good projec tion locally.

MR. CALVI IS PROUD TO BE THE FIRST LOCAL INDEPENDENT WITH Simplex E-7 PROJECTION

I also want to thank you for your splendid cooperation in working out the details of the change, and you have my hearty invitation to bring any interested persons to Hawthorne to inspect the equipment. We are proud to be the first local independent house to have it.

Sincerely yours,

E. S. Calvi

E. S. CALVI
PLAZA THEATRE

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